Technical Research Report 1142

PREDICTION OF SUCCESS IN ARMY AVIATION TRAINING

by HARRY KAPLAN

Office, Director of Laboratories

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U. S. ARMY PERSONNEL RESEARCH OFFICE

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An activity of the Chief, Research and Development

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Office, Chief Research and Development
Department of the Army

Washington, D. C. 20315

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FOREWORD

Selection of trainees for Army aviation pilot courses has been of continuing personnel management concern since the formation of the Air Force as a separate service in 1947. A long-range research approach to the problem of high attrition in Army aviation school courses for both officers and enlisted men has involved a series of validity studies to develop effective predictors of success in training and performance as Army pilots. The present Technical Research Report summarizes the important stages in the research and the more recent effort by which results were integrated in the development of a comprehensive selection program.

Since the inception of the program, a succession of U. S. Army Personnel Research Office research scientists have contributed to the formulation and conduct of the research. Among those who were concerned with the early exploration and conduct of the research program were Dr. Stanley S. Bolin, Dr. Leon G. Goldstein, Dr. E. Kenneth Karcher, Jr., Mr. Harold Martinek, and Dr. Neil J. Van Steenberg. Dr. Nathan Rosenberg was Task Leader for studies which resulted in several of the interim operational batteries. He was assisted by Mr. Donald M. Skordahl. Dr. Joseph Zeidner contributed technical assistance and direction over a considerable period of the research. Mr. Alan A. Anderson provided statistical continuity across successive validity studies. The final integrated battery was chiefly the collaborative effort of Mr. Harry Kaplan, who prepared the report, Dr. Marjorie O. Chandler, Mrs. Pauline Olson, and Mr. Cecil D. Johnson, Chief of the Statistical Research and Analysis Laboratory.

J. E. Uhlaner
Director of Laboratories

PREDICTION OF SUCCESS IN ARMY AVIATION TRAINING

BRIEF

Requirement:

Beginning in 1955, the Deputy Chief of Staff for Personnel established requirements for the development of instruments to select officers as fixed-wing pilot trainees and enlisted men as warrant officer candidate rotary-wing pilot trainees. In 1963, the requirement was expanded to provide for a consolidation of the separate programs.

Procedure:

To meet the initial requirement, research programs were conducted involving the experimental testing of 2000 enlisted men, 1200 officers, and 1200 ROTC cadets. Particular attention was given to the development and evaluation of measures to select enlisted personnel for rotary-wing training, including preflight (OCS-type) training to prepare graduates for warrant officer commissioning. Pending completion of a long-range research effort, partial results were utilized to develop interim test batteries for operational use. Finally, current operational data and previous research findings were combined to provide a basis for a comprehensive selection program.

Findings:

Selection tests initially developed by the Air Force and modified for Army use were effective in predicting fixed-wing training success for officers and ROTC cadets.

Selection tests developed by the U. S. Army Personnel Research Office were effective in predicting the success of enlisted applicants for warrant officer candidate preflight and rotary-wing training.

A comprehensive set of Flight Aptitude Selection Tests (FAST) was developed which provides effective measurement of both fixed-wing and rotary-wing aptitude for applicants to warrant officer candidate aviation training and of both fixed-wing and rotary-wing aptitude for applicants to officer aviation training.

Utilization of Findings:

Research findings in this report constitute the basis for operational Army aviation selection and allocation procedures adopted in 1965. Adoption was particularly timely in view of the greater role assigned to rotary-wing aircraft in tactical operations.

A comprehensive and integrated program of selection testing of applicants for flight training has been developed. Separate test batteries for officer applicants and warrant officer candidate applicants provide two scores for each applicant--a rotary-wing aptitude score and a fixed-wing aptitude score.

The current effort is an extension of an earlier research program. It has been possible to realize immediate and intermediate benefits from the program in that interim fixed-wing batteries were made operational in 1956 and 1961, and successively improved interim rotary-wing batteries were made operational in 1955, 1956, and 1961.

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PREDICTION OF SUCCESS IN ARMY AVIATION TRAINING

When the Army began to develop its own aircraft organization following World War II, selection of personnel to be trained as Army aviators posed no special problem. Many officers and warrant officers trained as pilots in the U. S. Army Air Corps had remained in the Army as aviators after the formation of the Air Force. When this supply of experienced manpower was exhausted and it became necessary to train men who had had no previous flying experience, a high rate of attrition among Army fixed-wing pilot trainees was soon noted. Improved screening was clearly needed to reduce loss of duty time, travel expense, and cost of flight training for applicants who were eliminated during training.

The attrition problem affected rotary-wing aviation training in the Army as well as fixed-wing training. Most would-be helicopter pilots entered aviation training as enlisted men and received their appointments as warrant officers upon completion of the Warrant Officer Candidate Aviator course. However, the leadership performance of many of these warrant officer pilots did not meet the needs of the service. The training program was therefore expanded to include intensive training of the type given in Officer Candidate schools. Attrition tended to be considerably higher than from officer courses because of the requirement for enlisted trainees to emerge as officers as well as pilots.

The double-edged attrition problem led to initiation of research by the U. S. Army Personnel Research Office at the request of the Deputy Chief of Staff for Personnel and with approval of the Chief of Research and Development. From the start of the program in 1955, selection for rotary-wing pilot training received the major attention. However, various test batteries--both fixed-wing and rotary-wing--were developed and made operational in response to the original selection needs and to meet the requirements of later developments in the Army's aviation program. Finally, integration of the fixed- and rotary-wing selection procedures into a comprehensive program was directed by DCSPER in 1963. The present report summarizes the separate fixed-wing and rotary-wing research efforts and the steps taken to consolidate the separate selection programs into the system which has been recommended for implementation.

FIXED-WING SELECTION RESEARCH

The Army Fixed-Wing Aptitude Battery

The Air Force had done exhaustive research on fixed-wing pilot selection. To take full advantage of the Air Force products, initial APRO research on fixed-wing selection was limited to the modification and adaptation of Air Force instruments and follow-up studies to determine their

effectiveness in selection for Army pilot training. The first such battery, AFWAB-1, was based on Air Force tests, and included Background Inventory, Aeronautical Information, Mechanical Principles, Aircraft Orientation, and Flight Visualization tests. It was introduced in the Army in 1956.

Predictor data for validation were obtained by administering AFWAB-1 to each entering class in the officer fixed-wing training course at Camp Gary, Texas, beginning in August 1957 and continuing for one year, giving a total of 1109 students. Total AFWAB-1 scores and scores on component tests were evaluated for effectiveness in discriminating between successful and unsuccessful flight training program (FTP) trainees.

A parallel study was conducted in response to a 1956 request by DCSPER that APRO evaluate the battery as a means of selecting students applying for Army ROTC flight training. The Army ROTC Flight Training Program, authorized in 1956, provides instruction in basic ground and in-flight fundamentals and is designed to enable students to qualify for Federal Aviation Agency private pilot certificates. AFWAB-1 was administered to 1245 applicants for the program from 1956 through 1959. Men were tested in ROTC summer camp following their junior year and prior to entrance into flight training.

Results indicated that AFWAB-1 could be a fairly effective instrument in reducing attrition in both training programs.[1] When the samples of flight trainees were ranked on AFWAB scores and divided into quarters, and percentages passing flight training were computed for each quarter, the percentages of successful trainees increased steadily from the bottom to the top quarter (Figure 1).

In February 1961, AFWAB-2, adapted from a later form of the Air Force Officer Qualifying Test, was implemented for administration to applicants for officer fixed-wing aviation training. To determine the effectiveness of the new battery, APRO obtained the test scores of applicants and determined how well the test predicted success in the course. The selective efficiency of the battery appeared to be comparable to that of AFWAB-1. AFWAB-1 was retained for ROTC selection.

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[1] The biserial validity coefficient for the composite score against the pass-fail training criterion was .41 (N = 1109); against the criterion of pass-fail by reason of flying deficiency, the coefficient was .32 (N = 740). In the ROTC study, the biserial validity coefficient against total pass-fail was .32 (N = 1245).

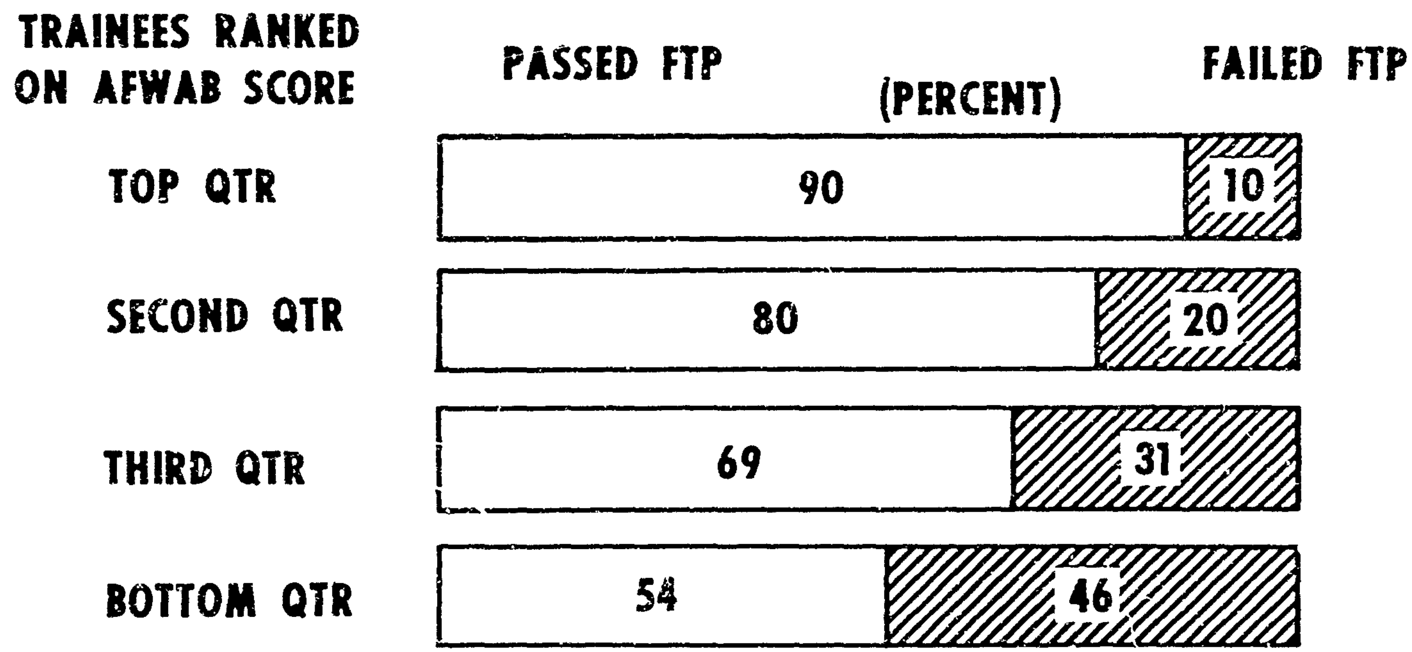

Figure 1. Comparative success in Army primary FTP of 1109 trainees

ROTARY-WING SELECTION RESEARCH

In APRO's rotary-wing selection research, a first approach, as with the fixed-wing research effort, was to try out existing Navy and Air Force aviation batteries. It was soon apparent that these tests were less effective in the Army rotary-wing situation than for fixed-wing training, probably because of the officer-candidate type of training that had been added to prepare the enlisted trainees for appointment as warrant officer pilots. For this reason, screening measures were needed which would select men who could successfully complete both types of training.

Accordingly, a long-range research program was initiated for the development and identification of more effective predictor measures. Some tests were developed specifically for the program; others were assembled from related programs. The total effort involved a variety of tests and experimentation with many different samples. Over 40 tests in all appeared promising enough to be incorporated into experimental batteries for comprehensive validation. The predictor tests were administered experimentally to enlisted students entering the U. S. Army Primary Helicopter School beginning with the class starting training in July 1955 and ending with the class which started training in July 1958. Measures of flying proficiency and measures of academic achievement and leadership performance were obtained as bases for evaluating the predictors. Different aspects of these criteria were measured for different phases of the research, but concentration was on pre-flight--the OCS-type training--primary flight training, and total performance in training. A description of the variables used in this research is contained in Appendix A.

Interim Operational Rotary-Wing Batteries

Concurrently with this long-range effort, APRO undertook a number of research studies as a means of satisfying immediate operational needs on an interim basis. Between 1955 and 1961, three interim batteries to help select helicopter pilot trainees were successfully implemented. Much of what was learned from the long-term effort in progress was applied in the operational situation. The first such battery, introduced in May 1955, emphasized identification of men with potential for success in pre-flight training. It was designed primarily to assure that graduates of the program would possess the personal and leadership characteristics that the Army had come to expect of warrant officers. OCS selection techniques were useful here--an evaluation report and a standard interview which APRO had previously shown to be predictive of leadership qualities in officer candidates. Revised OCS forms were later substituted.

Preliminary findings from the more comprehensive research effort were available soon after the two-test battery was instituted. As a result, two additional tests--Mechanical Principles and Situational Reasoning--were added to the battery. Th new four-test composite became operational in August 1956.

As more research evidence accumulated, it became evident that a broader range of abilities had to be tapped if substantial improvement in predictive effectiveness was to be attained. A third interim battery (ARWAB-1) was implemented in October 1961. This battery proved a fairly effective selection instrument; hence, it was decided to make it operational until all aspects of the total long-range research effort were completed. It consists of the OCS Board Interview, the OCS Evaluation Report, the Locations Test, the Complex Movements test, the Helicopter Pilot Self-Description Form, and the Helicopter Information test.

Results by Type of Predictor

Successive studies in which varying combinations of tests and other measures were administered experimentally yielded the basis for the following general evaluations of the different predictors of success in rotary-wing training and performance.

Background. Age, education, rank, and previous flying experience were non-test data analyzed in relation to passing or failing the training course, as well as in relation to specific aspects of the training program. Knowledge of these relationships could be a useful basis for administrative decision on establishment of non-test prerequisites for admission to training, such as accepting only those with 12th grade education, or only those with previous flying experience.

There was a slight tendency for students who successfully completed the course to be younger, better educated, and lower in rank than the average and to have had previous flying experience. The relationships did not add up to a degree of prediction that could safely be recommended for use by military management.

Personality Measures. Four types of personality and motivational measures were tried out during this research: psychiatric evaluation, evaluation by supervisors, board interview procedures, and self-description instruments. Since motivation and adjustment were judged to be of paramount importance, much of APRO's effort went into the development of the self-description measures. The most effective single test for predicting overall success in training was in fact a self-description instrument which incorporated the most effective content from four different tests upon which considerable previous experimentation had been conducted. However, the self-description measures, or will-do tests, were only moderately effective in predicting failure by reason of flying deficiency. These findings, of course, occasioned no surprise. They did furnish evidence that success in training for Army aviation required motivation, personal adjustment, and leadership attributes as well as flying skills.

Psychomotor Tests. Because a pilot engages in a considerable amount of psychomotor activity, apparatus tests which measure psychomotor abilities were included in the tryouts. Four Air Force tests were tried

out, even though they would entail expense and administrative difficulty in operational use. It was found that a combination of tests which included psychomotor measures would be somewhat more effective than the best combination of paper-and-pencil tests alone in reducing attrition due to flying deficiency. However, the advantage did not hold when it was a question of reducing overall attrition. Under peacetime conditions, therefore, use of psychomotor tests does not appear to be justified either by technical or practical considerations.

Cognitive Tests. The General Technical Aptitude Area (GT), a composite of the Verbal and Arithmetic Reasoning tests of the Army Classification Battery, was a good predictor of academic grade in the training course. However, it did not predict overall success in training. Its low relationship to training success appears to be due to the careful screening on general ability the trainees have had before being assigned to the aviation training course. Failure rates for academic reasons are therefore quite low, and the bulk of the attrition must be laid to other factors--among them a lack or low level of the special aptitudes needed. It could therefore be expected that tests measuring specific aptitudes found to be predictive of success in aviation training would be useful.

Cognitive, or can-do, tests were tailor-made for the most part to tap six psychological domains or content areas: spatial, mechanical, visual perception, eye-hand coordination, situational reasoning, and aviation information. The batteries recommended for operational use include tests in the three most effective areas: spatial, mechanical, and aviation information. Findings in this respect were consistent with those of the other services.

Batteries to Meet Future Operational Needs

Recommendations with respect to the content and weighting of a test battery vary with the specific operational needs the battery is designed to meet. In the past, when single batteries have been developed for a given program, APRO researchers have eventually been faced with the problem of developing new tests or revising existing ones, and then repeating a substantial part of the research cycle in order to revalidate the test and composite scores obtained from the revised set of tests. To keep to a minimum such recycling of research steps in Army aviation selection, tests were earmarked for use in model batteries to meet varying operational needs. With these batteries as models, changing requirements could be met by reassembling existing tests or by substitution of updated information tests.

To identify such batteries for Army helicopter pilot selection, 20 tests were analyzed in different combinations and for different purposes. Findings were used in designing model batteries for use under three operational conditions--peacetime, mobilization, and circumstances requiring pilots with special qualifications. For each operational condition, one battery was selected on the basis of its effectiveness in predicting

passing versus failing the training course in its entirety, another on the basis of its effectiveness in predicting passing the course versus failure due to flying deficiency. (Composition of the resulting batteries is shown in the Technical Supplement.) Thus, emphasis in selection can be placed either on flying proficiency or on success in the total training course. Overall success in the course is of course partially mediated by motivational and leadership qualifications.

The peactime batteries are constituted without the psychomotor tests. The pair of mobilization batteries, on the other hand, provide for tests of psychomotor abilities on the assumption that special centers for test administration will be set up. A third pair of batteries, termed "core" batteries, contain only cognitive paper-and-pencil tests and permit flexibility of application. For example, they can be added to tests of other domains when special kinds of applicant pools are to be screened--enlisted pilots to be trained for tactical missions, for example.

The comparative effectiveness of each of the batteries is illustrated in Figure 2. In predicting overall training success, the peace-time battery is about equal in effectiveness to the mobilization battery, and the core battery is considerably less effective than the more complete batteries. In predicting flight performance, the mobilization battery is somewhat more effective than the other batteries, and the core battery is almost as effective as the more complete peace-time batteries.

COMPREHENSIVE SELECTION PROGRAM FOR AVIATION TRAINING

As a result of APRO research, the Army by 1963 had in operation valid procedures for selecting enlisted men to be trained as warrant officer helicopter pilots. With these men, selection placed considerable emphasis on personality characteristics needed for non-flying duties that would be required of them as warrant officers. Also in operation were valid procedures for selecting officers for fixed-wing flight training, in this case concentrated on abilities and information predictive of fixed-wing aviation performance. What the Army did not have were procedures with special applicability for selecting enlisted men for fixed-wing aviation training or for selecting officers for rotary-wing training--although by this time the Army was training both officers and enlisted men without previous flying experience in each type of flying.

However, when DCSPER directed an integrated system of aviation selection, the accumulated body of research findings on pilot trainee selection afforded an adequate basis for constituting a comprehensive program without extensive additional research.

The general plan required the development of separate batteries for officer applicants and for warrant officer candidate applicants. Each battery was designed to provide two scores for each applicant: a rotary-wing aptitude score and a fixed-wing aptitude score. The batteries taken

	PASS-FAIL TOTAL	PASS-FAIL FLYING
MOBILIZATION BATTERIES	.46	.54
PEACETIME BATTERIES	.45	.43
CORE BATTERIES	.37	.41

Figure 2. Comparative effectiveness of model rotary-wing batteries in terms of correlation with training performance

together are called the Flight Aptitude Selection Tests (FAST). The batteries were assembled on the basis of flight training data and data collected on the job for pilots assigned in selected locales both in the continental United States and in Europe. The constitution of these batteries is shown in Figure 3.

In assembling these batteries, tradeoffs between validity and operational considerations were necessary to achieve an economy of tests across programs. The FAST batteries are more effective for selecting enlisted applicants for rotary-wing training than is the ARWAB, particularly with respect to flight performance. The Rotary-Wing Warrant Officer Candidate tests maximize selection for both successful completion of training and flying proficiency. Effectiveness for selection of officer applicants to fixed-wing training is unchanged, since battery content is identical with that of AFWAB-2. Effective selectors for enlisted fixed-wing training and for officer rotary-wing training are introduced for the first time.

The recommended FAST batteries allow each applicant to be evaluated on the basis of his aptitude for a specific training course, in contrast to previous operational procedures which did not distinguish between fixed-wing and rotary-wing aptitude.

With the two aptitude scores obtained for each applicant, individuals who qualify can be allocated either to fixed-wing or to rotary-wing training based on consideration of the relative strength of their aptitudes. Two advantages to the Army should accrue from the revised procedure: Input to the aviation training program should increase without any lowering of standards, inasmuch as more of the applicant pool may be expected to qualify for one or the other type of training. Also, increased validity of the selection measures will result in a higher rate of success in training. In the case of enlisted applicants, the new battery affords an estimated increase in successful completion of the aviation course from 50 percent to 67 percent.

Assume that 400 applicants are tested and that the qualifying score is set so as to accept the highest 50 percent. If only one general score is used, 200 in all will be accepted for fixed-wing and rotary-wing training. With current attrition rates, 134 of these will qualify as pilots. In comparison, when applicants for fixed-wing training are accepted on a composite of appropriate aptitudes, and applicants for rotary-wing training are selected on a different aptitude composite, an estimated 236 will be in the highest 50 percent on one or the other aptitude score. An estimated 158 will qualify as pilots. In sum, more trained pilots are made available without an increase in the number of applicants tested.

TEST	OFFICER		WARRANT OFFICER	
	Rotary	Fixed	Rotary	Fixed
BIOGRAPHICAL INFORMATION	X	X		
MECHANICAL PRINCIPLES		X		
FLIGHT ORIENTATION		X		
AVIATION INFORMATION				
FIXED-WING		X		X
ROTARY-WING	X		X	
MECHANICAL INFORMATION		X		X
MECHANICAL FUNCTIONS	X		X	
VISUALIZATION OF MANEUVERS	X	X	X	X
INSTRUMENT COMPREHENSION		X		X
COMPLEX MOVEMENTS	X		X	
STICK AND RUDDER ORIENTATION	X		X	
SELF-DESCRIPTION			X	X

Figure 3. Constitution of Flight Aptitude Selection Tests

DEVELOPMENT AND VALIDATION OF ARMY AVIATION SELECTION TESTS

TECHNICAL SUPPLEMENT

TECHNICAL SUPPLEMENT

SELECTION BATTERIES FOR FIXED-WING TRAINING

For Army fixed-wing aviation, the policy of adopting--and adapting--Air Force instruments proved economical and fairly satisfactory, since the training performance to be predicted was essentially the same. The first Army Fixed-Wing Aptitude Battery (AFWAB-1) was implemented in 1956 and subsequently validated on applicants to the officer fixed-wing training course and on Army ROTC students applying for the flight training program.

Validity estimates for AFWAB-1, obtained in two studies (1,2), are shown in Table 1. The validity estimate for the composite score in each study is a biserial r not corrected for restriction in range. Optimal weighting of the test components did not materially change the results. On the basis of the results obtained in these studies, it was concluded that AFWAB-1 was a fairly effective instrument for predicting success in officer fixed-wing training courses and in the Army ROTC Flight Training Program. AFWAB-2 was implemented for use with applicants for officer fixed-wing training courses in February 1961. Validity estimates, determined in part on the basis of current operational data, were equivalent in magnitude to those obtained for AFWAB-1. The tests comprising AFWAB-1 and AFWAB-2 are shown in Figures 4 and 5.

VALIDITY OF ROTARY-WING SELECTION TESTS--PRELIMINARY INVESTIGATION, 1955

In 1955, APRO was requested to initiate research for selection of rotary-wing pilot trainees. There was reason to believe that selection problems for rotary-wing pilot trainees might be unique with respect to the abilities involved in training and on the job, as well as with respect to the characteristics of the basic applicant population--enlisted applicants for rotary-wing training.

Table 1

BISERIAL VALIDITY COEFFICIENTS OF AFWAB-1 COMPONENT TESTS AND COMPOSITE SCORE

	Officer Sample						ROTC Sample		
	Pass-Fail Training (N = 1109)			Pass-Fail Flying (N = 740)			Pass-Fail Training (N = 1245)		
Variable	Mean	S.D.	r	Mean	S.D.	r	Mean	S.D.	r
Background Inventory	9.79	3.56	.15	9.63	3.64	.18	9.77	3.46	.20
Aeronautical Information	9.63	6.08	.34	10.92	6.06	.46	5.47	4.68	.20
Mechanical Principles	15.46	5.74	.27	15.42	5.67	.22	15.42	6.01	.21
Aircraft Orientation	10.74	6.10	.28	10.42	6.95	.18	11.51	6.37	.23
Flight Visualization	10.92	8.01	.30	9.91	7.83	.23	12.34	8.07	.24
AFWAB Composite Score	56.55	20.18	.41	56.36	20.65	.32	54.50	19.85	.32

Background Inventory, DA Form 6234: 30 five-choice items dealing with the individual's family, education, hobbies, and employment background.

Aeronautical Information Test, DA Form 6235: 30 five-choice items dealing with the individual's general and technical knowledge of aeronautical information.

Mechanical Principles Test, DA Form 6236: 30 five-choice items dealing with the ability of the individual to understand mechanical principles.

Aircraft Orientation Test, DA Form 6237: 28 five-choice picture items dealing with the ability of the individual to visualize the relationship between an airplane and the territory over which it flies. This test differs from its prototype in the Air Force Officer Qualifying Test in that silhouettes are used instead of photographs.

Flight Visualization Test, DA Form 6238: 28 five-choice picture items dealing with the ability of the individual to visualize airplane maneuvers. In this test also, silhouettes were substituted for the photographs used in the Air Force test.

Composite Score: Obtained by summing the final scores on the five tests. The final score on each test consists of number right less any correction for guessing.

Figure 4. Tests of the Army Fixed-Wing Aptitude Battery, AFWAB-1

BOOKLET I, DA FORM 6244

Part 1 Aviation Information: 30 four-choice and five-choice items which tap the examinee's interest in and motivation for flying. Content deals with general and technical aspects of aviation information.

Part 2 Mechanical Information: 30 five-choice items dealing with the mechanical aspects of automotive information.

Part 3 Mechanical Principles: 30 five-choice items in which the examinee solves problems on the basis of his understanding of mechanical principles.

Part 4 Biographical Information: 48 multiple-choice items dealing with the examinee's family, education, hobbies, and vocational interests.

BOOKLET II, DA FORM 6245

Part 5 Visualization of Maneuvers: 30 five-choice picture items. In each item, the examinee is required to indicate how the position of a pictured airplane changes after specified maneuvers. This test is similar to, but not identical with, the Flight Visualization Test used in AFWAB-1.

Part 6 Instrument Comprehension: 30 five-choice picture items; in each item, the examinee is required to determine which one of five planes has a position and direction consistent with instrument readings pictured on an artificial horizon and a compass.

Part 7 Flight Orientation: 50 picture items with a maximum of 75 scorable responses. Each item taps the examinee's ability to visualize the relationship between an airplane and the territory over which it flies. This test is similar to, but not identical with, the Aircraft Orientation Test in AFWAB-1.

COMPOSITE SCORE

The AFWAB-1 Composite Score is obtained by summing the final scores of tests in the two booklets. The final score in each booklet consists of number right less any correction for guessing.

Figure 5. Tests of the Army Fixed-Wing Aptitude Battery, AFWAB-2

Since no selection tests specifically designed for selection of rotary-wing trainees existed in 1955 and there was pressing need to implement a selection program at the earliest possible time, the effectiveness of existing measures was evaluated in an exploratory study. These existing measures consisted of the then operational Navy and Air Force aviation batteries and of aptitude area scores derived from the Army Classification Battery. The major objective of the study was to identify tests which could be used on an interim basis for selecting enlisted helicopter pilot trainees (3).

The sample consisted of approximately 400 trainees in the Army Cargo Helicopter Pilot Course (ACHPC) initially located at Fort Sill, Oklahoma; then at Fort Rucker, Alabama. During this period, officers and enlisted men were trained in the same classes, enlisted men selected for training had to have scores of 110 or better on three aptitude areas, and a large proportion of the provided sample had previous flying experience. Since the population to which the results were to be considered applicable was to consist of enlisted men most of whom would have had little or no flying experience, data were analyzed separately for officers and enlisted men, and validity coefficients were computed with flying experience held constant.

The predictor variables for this study are listed and described in Figure 6. Previous flying experience, treated as a dichotomous variable with the split between 74 and 75 hours of previous flying, was the control variable. Two criteria were used: the overall criterion (passing or failing the ACHPC) and the flying criterion (passing or failing due to flying deficiency).

Since the correlation between previous flying experience and the flying criterion was very high--the phi coefficient was .85 for officers and .69 for enlisted men--it was imperative to partial out the effect of previous flying experience, if the results were to be generalized to an input population in which previous flying experience was lacking. When this was done, none of the obtained partial validity coefficients for the enlisted sample against the flying criterion were as high as those ordinarily obtained against fixed-wing criteria in a large number of previous Air Force studies. It was concluded that it would be necessary to construct new experimental measures designed to predict success for an applicant pool consisting of enlisted men volunteering for helicopter pilot training, and to enter upon an extensive research program. The research results revealed promising content areas for further research, as well as for interim operational use: measures of aviation information, mechanical knowledge or comprehension, situational or practical reasoning, and personality characteristics (3).

AIR FORCE TESTS
(Aviation Cadet Qualifying Test)

Pilot Biographical Inventory. Five-choice background items.

Officer Qualification Biographical Inventory. 17 five-choice background items.

Aviation Information. 22 five-choice items covering experience or knowledge of aircraft.

Mathematics. 15 five-choice mathematics items.

Current Affairs. 15 five-choice items on current events.

English Usage. 15 five-choice items on grammar, spelling, etc.

General Science. 15 five-choice science items.

Practical Judgment. 15 five-choice situational reasoning items.

Reading Comprehension. 15 five-choice paragraph interpretation items.

Mechanical Principles. 30 five-choice mechanical items.

Aerial Orientation. 30 five-choice visualization items.

Arithmetic Reasoning. 30 five-choice arithmetic items.

Visualization of Maneuvers. 30 five-choice items on visualization of airplane maneuvers.

NAVY TESTS

Naval Aviation Qualification Test. A preliminary screening device, consisting of 115 items, with a variable number of choices, covering instrument reading, vocabulary, comparison of letters and numbers, and practical judgment.

Naval Aviation Selection Battery.

Mechanical Comprehension. 76 three-choice mechanical items.

Spatial Apperception. 30 five-choice visualization items.

Biographical Inventory. 90 items, with a variable number of choices, covering background, interest, information, and judgment.

Figure 6. Air Force and Navy fixed-wing selection tests evaluated to predict success in Army helicopter pilot training

LONG-RANGE RESEARCH PROGRAM--1955-1964

Overview

Scores on experimental predictor tests as well as on background, reference, and criterion measures were obtained for enlisted input into Army helicopter training over a three-year period (1955-58). Because of the large number of variables involved it was not feasible to administer all measures to all students. Consequently, succeeding classes were grouped into separate samples; the same variables were administered to the members of any one sample, with some overlapping tests being administered across samples. In addition, new tests were added in the various successive samples and old tests were dropped. Statistical analysis was conducted by stages. Three successively improved interim batteries were implemented based on partial validations during the first three stages of the analysis. The fourth stage of analysis resulted in a single self-description instrument which was recommended for final operational use. The fifth stage of the analysis constituted the final validation, and resulted in the development of models for different batteries designed to meet changing operational needs.

Population and Samples

The population is defined as all enlisted applicants for Army helicopter pilot training who meet administrative and general mental prerequisites. During the period of data collection, applicants were considered for admission if they were between 20 and 30 years old, had a score of 110 or higher on the General Technical (GT) Aptitude Area of the Army Classification Battery, met medical standards for flying, and had fulfilled certain other administrative requirements. Since successful completion of the course of training resulted in a warrant officer appointment, leadership potential represented an important selective factor.

In addition to preselection on GT score, trainees in all except the first sample had undergone further selection on the basis of the first interim battery (two-test) or the second interim battery (four-test). Finally, additional selection occurred when assignments to training were made in the Office of the Chief of Transportation. When training quotas had been filled from the pool of enlisted applicants, those trainees who were passed over were placed on a waiting list and were reconsidered together with new applicants when assignments to subsequent new classes were to be made.

Samples were constituted as follows, each sample being, with some exceptions, based upon administration of a common body of predictor tests:

<u>Sample I</u>. Classes 56-1 through 56-8 and part of 56-10, starting training in July 1955 through March 1956. Out of a total of 444 cases used in analysis, 88 were selected on the first interim (two-test) battery, the remainder being assigned without reference to any selection battery.

Sample II. Classes 56-10 through 56-13, starting training in March 1956 through June 1956 (N = 154). Students in Sample II had been selected on the two-test interim battery.

Sample III. Classes 57-1 through 57-4, 57-6, and 57-7 starting training in July 1956 through January 1957 (N = 296), also selected on the two-test battery.[a]

Sample IV. Classes 57-8 through 58-7 starting training in February 1957 through January 1958. Out of a total of 603 men in Sample IV, 357 h. been selected for training on the two-test interim battery and 246 on the four-test interim battery. In order to apply appropriate restriction in range corrections to the two groups, Sample IV was subdivided for analysis purposes into Sample IV' and Sample IV''

Sample IV'. Classes 57-8 through 57-12. These 357 students had been selected on the two-test interim battery.[a]

Sample IV''. Classes 58-1 through 58-7. These 246 students had been selected on the four-test battery.[a]

Sample V. Classes 58-9, 58-11, and 59-1, starting training February, April, and July 1958. This sample of 162 students had been selected for training on the four-test interim battery.

The samples also differed in the leadership training received. For all but the last two classes of Sample I, all phases of training were conducted under OCS-type conditions; leadership training was given concurrently with the flight and academic training. For the last two classes of Sample I and for Samples II through V, a separate pre-flight phase, stressing leadership, preceded flight training.

Variables

Criterion Variables. Altogether, 14 criterion variables (described in Appendix A) were utilized during the various phases of the research. For test selection purposes, the criterion measures employed were passing versus failing the helicopter pilot training course--Pass-Fail Total (PFT),

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[a] In the development of a final self-description form, a portion of the students in Samples III and IV were used for item analysis. The remainder, held out for cross-validation of this instrument, consisted of 200 men from Sample IV' (designated as Sample Ac 7) and 96 men from Sample IV'' (designated as Sample Ac 8).

and passing versus failing due to flying deficiency--Pass-Fail Flying (PFF). The remaining criterion measures dealing with preflight performance, special aspects of flight performance, leadership performance, academic performance, and on-the-job performance were utilized largely for exploratory studies and other special purposes (4,5,6,7,8).

Background and Reference Variables. Background variables consisting of age, education, rank, and previous flying experience, and reference variables consisting of Army Classification Battery test scores were evaluated in the early exploratory stages of the research (4,5,9). These variables are described in Appendix A.

Experimental Predictors. The complete set of predictors is described in Appendix A.

Method of Analysis

Data were analyzed by stages in order to accomplish interim objectives. Data from different samples were combined where appropriate.

Stage 1. An exploratory analysis of data collected on Sample I, in which the relationships among 4 background variables, 11 reference variables, 11 cognitive predictor variables, 15 personality predictor variables, and 10 criterion variables were investigated (4).

Stage 2. An exploratory analysis primarily utilizing Sample II data, in which the relationships among 4 psychomotor apparatus tests, 13 cognitive predictor variables, 13 personality predictor variables, and 9 criterion variables were investigated. Validity results in Sample I and Sample II were also compared for 24 overlapping predictor variables (5).

Stage 3. A partial validation study resulting in the selection of a six-test interim battery which was implemented in October 1961. A single criterion measure, Pass-Fail Total (PFT), was utilized in this study. Twenty-four paper-and-pencil predictor tests were considered. The 11 most promising predictors were subjected to a test selection procedure, on the basis of combined results across Samples I through IV. Sample V was utilized to generate the intercorrelation matrix. Cross-validation of the battery could not be attempted (10).

Stage 4. An intensive analysis of self-description materials conducted in two parts. In the first part of the study, data from Sample III on four self-description instruments and six criterion measures were used to validate 57 personality constructs and one overall judgment key (6). In the second part of the study, data from Samples III and IV were used to analyze the items in three self-description instruments against pass-fail total, on-the-job rating, and peer leadership rating criteria. Six item analysis keys were developed and cross-validated. Results were utilized in the development of a final self-description form for operational use.

Stage 5. A final validation in which 20 predictor tests were validated separately against the Pass-Fail Flying and Pass-Fail Total criteria. Separate test selections were conducted with different combinations of these tests to develop several model batteries for operational use under different conditions. Since all of the students in the samples used had been selected for training on the basis of one of the interim batteries, validity coefficients were corrected for restriction in range.

The effect of selection on the operational batteries was given careful consideration in this study. If a criterion having a continuous distribution had been utilized, the restriction in range effect of selecting on the operational tests could have been removed by the conventional three-variate correction formulae. With the low validity coefficients and the relatively high correlation with the experimental tests, a suppressor effect results from the removal of a certain amount of variance in the criterion and predictors associated with the operational test variance. At some level of validity, the positive suppressor effect will exactly cancel out the negative restriction effect, and the predictor-criterion validity coefficients will remain the same after correction. In this study, the validity of the operational tests ranged around a point only a little above this "break-even" point. Thus the effect of selection would, on the average, have been slight even if the criterion had been a continuous variable.

Since the criteria used in this study were dichotomized variables (pass vs. fail), special techniques for counteracting the effect of selection had to be developed. The commonly used techniques either assume that the amount of restriction is monotonically related to score variance, or, as in the case of the G-coefficient, cannot appropriately take into account the effect on the correlation between two variables that is introduced by selection on a third variable. Since the variance of a dichotomized variable will either go up or go down as a result of selection and a three-variable model definitely applies to our research problem, the conventional correction methods could not be utilized.

Two separate statistics are required for the present problem of correcting a validity coefficient based on a continuous and a dichotomous variable; one for direct selection on the continuous variable where the G-coefficient is appropriate; and one for indirect selection effects on both variables. The latter requires a more complex procedure for computing a corrected "three-variable biserial coefficient." This method makes use of the G-coefficient as the correlation coefficient between the appropriate operational test and the criterion, using the correlation coefficient between the operational test and each experimental test as corrected for restriction in range by the conventional formula for continuous variables, the point of cut on the operational test, and means and standard deviations of all three variables to estimate the value of the validity coefficient in an applicant population.

The "three-variable biserial" sometimes raised and sometimes lowered validity coefficients when compared to the uncorrected biserial correlation coefficients in this study. This more complex procedure was found to agree fairly closely with results obtained by separately computing point biserials in each group, averaging these coefficients weighted by the size of the groups, and then converting to a biserial coefficient by utilizing the p-value in the combined groups sample. The more complex correction procedure was used in accomplishing the test selection and cross validation for the model batteries, but the more simple method (involving point biserials) was used to obtain validity coefficients of variables not included in the test selection studies.

Results for Stages 1 through 3 and the first part of Stage 4 were described in previously published reports (4,5,6,10). The following aspects of the research have not previously been reported:

1. Development and validation of a self-description form for inclusion in the model batteries and for operational use.

2. Selection of tests comprising the model rotary-wing batteries and their cross-validation.

3. Validity coefficients of the three interim operational batteries based on the same samples utilized in estimating the validity of the model batteries.

4. Validity estimates for all individual variables computed across samples.

Development and Validation of a Final Self-Description Form

Exploratory studies using Samples I and II revealed that personal characteristics as measured by self-description instruments were highly predictive of success in the training program. Of nine self-description scores developed in other programs, scores on eight, when correlated against the pass-fail school training criterion, had validity coefficients which were significant at the .05 level or better. The most valid of these measures was therefore scheduled for administration to the final validation sample. It was planned that the final self-description form would contain the most valid items from measures developed in other programs, as well as items tailor-made to predict success in rotary-wing training.

Four new experimental personality questionnaires were constructed for tryout. The new questionnaires, designed to provide a more systematic coverage of background, attitudes, and interests were: Activities Inventory (AI), PT 3145; Personal Description Inventory (PDI), PT 3159; Helicopter Pilot Trainee Attitude Questionnaire (HPAQ), PT 3147; and Personal History Form, PT 3161. All four instruments were utilized in a previously reported study dealing with personality constructs (6). However, the

Personal History Form (PT 3161) was eliminated from consideration for item analysis because preliminary analysis had not indicated promise, and further statistical work was judged to be excessively expensive. The three remaining inventories furnished a pool of 487 items for analysis.

The objective of the proposed item analysis was to select items which would be valid across three criteria: pass-fail school training, peer leadership, and success on the job. The new questionnaires were introduced into the experimental batteries in July 1956 and were administered to approximately 900 students between July 1956 and January 1958. In January 1958, these questionnaires were modified and a revised version was administered to subsequent classes. A second modification occurred when the measures were administered to an on-the-job sample in 1958. In both instances, the modification consisted of dropping items, primarily to reduce testing time. For the school sample, the reduced item pool consisted of 266 items; for the on-the-job sample, the reduced item pool consisted of 344 items.

Examinees were allocated to samples to predict each criterion as follows:

1. Pass-fail school training (a dichotomy of graduation versus failure for any reason)

   a. Item analysis sample, N = 600

   b. Cross-validation sample, N = 296

2. On-the-job rating (scores on a rating scale entitled "Overall Value to the Army" obtained during visits to operational helicopter units)

   a. Item analysis sample, N = 152

   b. Cross-validation sample, N = 240

3. Peer leadership rating (a leadership evaluation obtained from peers during the 18th week of school training)

   a. Item analysis sample, N = 133

   b. Cross-validation sample, N = 152 (these are the same examinees used in item analysis for the on-the-job criterion)

   c. Cross-validation sample, N = 141 (these are graduates from the cross-validation sample for the pass-fail school criterion)

Validity coefficients for items of the self-description instruments were obtained for the three criteria. Six measures were developed and cross-validated. The best of these was the multiple criterion score consisting of 49 items which were valid across the three criteria, with cross-validity coefficients as follows:

Criterion	Biserial r
Pass-Fail School Training	.28
Peer Leadership	.12
Job Performance	.24

With respect to the school criteria, the multiple criterion score provided unbiased results for 296 examinees of which 200 were in Sample IV' and 96 were in Sample IV'' (designated as Samples Ac 7 and Ac 8, respectively).

Sample V, which had not been used in the item analysis study, provided another source of unbiased data. However, Sample V examinees had received an abbreviated version of the four new experimental self-description instruments. Consequently, data were available on only 20 of the 49 items in the multiple criterion measure. These 20 items became an abbreviated multiple criterion measure which was applied to the Sample V data. Sample V also provided data for obtaining an unbiased validity estimate of the most valid measure borrowed from other programs.[3]

The sources from which items were selected for the final self-description form were the multiple criterion measure and the Army Self-Description Blank (Recruit), DA PRT 2712. Considering all available validity data, 190 items were selected for inclusion in the final form. Of these, 103 items were to be scored for operational use; the remaining items were to be included for research purposes.

To determine the validity of this instrument against school criteria, each obtained validity coefficient was adjusted to allow for differences in key length. The obtained coefficients were corrected for restriction in range. The estimated biserial validity coefficients of the final form against three school criteria were:

Pass-fail school training	.36
Pass-fail flying	.21
Pass-fail preflight	.33

[3] This was the Infantry Key (designated SDB Infantry) from the Army Self-Description Blank--Recruit, DA PRT 2712. The same key was used operationally in the third interim battery, ARWAB-1, implemented in October 1961. In ARWAB-1, the title of this instrument is Helicopter Pilot Description Form HPDF-1, DA Form 6243.

Validity of Model Batteries

Certain limitations of the final validation stem from the fact that enlisted input into helicopter training was halted abruptly in 1958. As a consequence, it was not possible to obtain a sufficiently large hold-out sample to provide reliable results which would be completely free from bias, and which would include all relevant variables. Certain expedients were therefore adopted in order to minimize the effects of these limitations.

Since no single sample was considered large enough to provide reliable results, data were combined across samples. Because the magnitude of the validity coefficients obtained in earlier samples may have affected the selection of variables included in later samples, it was decided that it would not be possible to obtain an unbiased estimate of validity if results from the earlier samples were used in the analysis. For this reason, only data from Samples IV', IV'', and V were used.

When these data were combined, a full matrix of 20 predictor variables (Figure 7) and two criterion variables (Pass-Fail Total and Pass-Fail Flying) was obtained. Test selection procedures were conducted to generate six model batteries as follows:

1. Warrant Officer Candidate Mobilization Battery to predict Pass-Fail Total

2. Warrant Officer Candidate Mobilization Battery to predict Pass-Fail Flying

3. Warrant Officer Candidate Peacetime Battery to predict Pass-Fail Total

4. Warrant Officer Candidate Peacetime Battery to predict Pass-Fail Flying

5. Core Battery to predict Pass-Fail Total

6. Core Battery to predict Pass-Fail Flying

The validity coefficients obtained as a result of the above procedures were back validities. In order to obtain an unbiased estimate of validity, it was necessary to use a hold-out sample or adopt some other expedient measure. Since a hold-out sample was not available, the following procedure to determine the amount of shrinkage which could be expected was adopted. Four reduced matrices consisting of 14 of the 20 variables were obtained. Two trial validations, each including test selection and cross-validation, were performed.

PSYCHOMOTOR TESTS	PERSONALITY AND LEADERSHIP VARIABLES
Complex Coordination	Qualification Report (OCE-2 or OIR-1)
Rotary Pursuit	Board Interview (OCE-4 or OLB-1)
Rudder Control	Self-Description Form

COGNITIVE TESTS

Spatial Content Area	Mechanical Content Area
Aircraft Orientation	Mechanical Ability
Complex Movements	Mechanical Functions
Flight Visualization	Mechanical Principles
Instrument Comprehension	**Aviation Information Content Area**
Locations (Dark)	Flying Information
Locations (Total)	Helicopter Information
Spatial Orientation	**Situational Reasoning Content Area**
Stick and Rudder Orientation	Situational Reasoning

Figure 7. Pool of experimental tests used to generate model batteries

Samples for the reduced matrices were:

1. Samples IV' and IV'' combined

2. Samples IV'' and V combined

3. Sample V

4. Sample Ac 7 (This sample consisted of a group of examinees who had previously been held out for purposes of cross-validating the self-description instruments.)

In the first trial validation, the reduced matrix consisting of data on Samples IV' and IV'' combined was used to obtain the pass-fail total back-validity for the best four-test composite (r = .499), and then Sample V data were used to obtain the cross-validity (r = .434). In the second trial validation, the reduced matrix consisting of data on Samples IV'' and V combined was used to obtain the pass-fail total back-validity for the best four-test composite (r = .553) and then Sample Ac 7

data were used to obtain the cross-validity coefficient (r = .462). Since the average shrinkage for data from the two studies was .078, this figure was used as a conservative estimate of shrinkage on the full matrix. The composition of the six model batteries and their validity coefficients after correction for shrinkage are shown in Table 2.

Means, standard deviation, and intercorrelation coefficients for the predictor variables as well as validity coefficients for each variable in the full and reduced matrices are shown in Appendix B.

Validity of Interim Operational Rotary-Wing Batteries

Pending completion of the research, three successively improved rotary-wing batteries were implemented on an interim basis, in May 1955, August 1956, and October 1961, respectively (Figure 8). Since estimates of validity for these batteries had been made on the basis of incomplete data (10), it was decided to recompute the validity coefficients utilizing the same basic data which had gone into the computation of the validity coefficients for the model batteries. Computation was accomplished by applying the operational raw score weights to the tests involved, and then deriving a correlation of sums using biserial r's (Table 3).

Validity of Individual Variables

Validity data on the model and interim operational batteries provide information on less than half the predictor variables tried out. Scattered results for most of the remaining variables are contained in previously published reports. A complete and definitive summary of results is included in the following section of the present report.

Results

Background and Reference Variables. Validity coefficients between these variables and eight criterion measures are presented in Table 4. The most striking findings are the consistently high correlations between ACB-type measures and academic rank. These results indicate that using ACB tests as screening devices can reduce attrition due to academic deficiency. And in fact this is what appears to be happening. A cutting score on the General Technical Aptitude Area (GT) is used operationally to screen applicants for training, and failures for academic reasons are a minor cause of attrition in training. However, when the relationships between ACB tests and the other criteria are studied, it becomes evident that a tailor-made battery is needed if further substantial improvement in the attrition rate is to be obtained.

Table 2

COMPOSITION AND VALIDITY COEFFICIENTS OF MODEL FOUR-TEST ROTARY-WING BATTERIES

BATTERIES SELECTED TO MAXIMIZE PASS-FAIL TOTAL VALIDITY			BATTERIES SELECTED TO MAXIMIZE PASS-FAIL FLYING VALIDITY		
Test	Content Area	Pass-Fail Total r	Test	Content Area	Pass-Fail Flying r
Mobilization Battery			Mobilization Battery		
Complex Movements	Spatial		Complex Coordination	Psychomotor	
Self-Description	Personality		Rudder Control	Psychomotor	
Helicopter Info	Aviation Info.		Helicopter Info.	Aviation Info.	
Complex Coordination	Psychomotor		Self-Description	Personality	
Composite		.455	Composite		.544
Peacetime Battery			Peacetime Battery		
Self-Description	Personality		Mechanical Functions	Mechanical	
Complex Movements	Spatial		Helicopter Info.	Aviation Info.	
Helicopter Info.	Aviation Info.		Self-Description	Personality	
Mechanical Functions	Mechanical		Stick & Rudder Orient.	Spatial	
Composite		.454	Composite		.426
CORE Battery			CORE Battery		
Complex Movements	Spatial		Mechanical Functions	Mechanical	
Helicopter Info.	Aviation Info.		Helicopter Info.	Aviation Info.	
Stick & Rudder Orient.	Spatial		Stick & Rudder Orient.	Spatial	
Mechanical Ability	Mechanical		Mechanical Ability	Mechanical	
Composite		.366	Composite		.405

MAY 1955 BATTERY

Officer Leadership Board Interview

Officer Leadership Qualificatior Report

AUGUST 1956 BATTERY

Mechanical Principles

Situational Reasoning

Officer Leadership Board Interview

Officer Leadership Qualification Report

OCTOBER 1961 BATTERY (ARWAB-1)

Locations

Helicopter Pilot Description

Helicopter Information

Complex Movements

Officer Leadership Board Interview

Officer Leadership Qualification Report

Figure 8. Interim operational rotary-wing batteries

Table 3

MEANS, STANDARD DEVIATIONS, AND VALIDITY COEFFICIENTS OF INTERIM OPERATIONAL ROTARY-WING BATTERIES

Tests	Variable Number	Operational Weight	Adjusted		Validity Coefficients	
			Mean	S.D.	PFT	PFF
First Interim Battery						
Qualification Report (OCE-2/OLR-1)	205a	.50	56.83	11.03	.10	.07
Board Interview (OCI-4/OLB-1)	206a	1.00	27.65	6.59	.13	-.01
Composite			84.48	14.02	.14	.05
Second Interim Battery						
Qualification Report (OCE-2/OLR-1)	205a	.25	28.42	5.52	.10	.07
Board Interview (OCI-4/OLB-1)	206a	.50	13.82	3.29	.13	-.01
Situational Reasoning	158	1.00	13.54	4.36	.12	.02
Mechanical Principles	159	1.00	12.13	5.75	.16	.25
Composite			67.91	11.32	.21	.17
Third Interim Battery (ARWAB-1)						
Locations	121	2.00	29.28	8.06	.02	.06
Helicopter Information	149	1.00	13.31	6.27	.27	.34
Complex Movements	148	1.00	28.89	8.96	.34	.19
Helicopter Pilot Description Form	216	1.00	85.51	9.79	.36	.21
Qualification Report (OCE-2/OLR-1)	205a	.25	28.42	5.52	.10	.07
Board Interview (OCI-4/OLB-1)	206a	1.00	27.65	6.59	.13	-.01
Composite			213.16	22.36	.44	.30

Table 4

VALIDITY OF BACKGROUND AND REFERENCE VARIABLES

Variables	N	Mean	S.D.	Validity Coefficients: Total	Pass-Fail: Flying	Pass-Fail: Preflight	Leadership Ranking: WOC-1 (Reflected)	Leadership Ranking: WOC-3 (Reflected)	Flight: % Sat	Flight: Grade	Academic Rank (Reflected)
BACKGROUND											
Age	1628	26.49	2.64	-110[a]	-157	-073	174	151	-075	-140	-050
Education	1626	12.23	.99	064	-046	116	-091	-060	-019	-027	116
Rank	1647	5.35	1.07	-074	-087	-015	337	360	-041	-043	-051
Previous Flying Experience	1653	.09	.28	165	213	025	-059	-103	161	173	088
REFERENCE											
Aptitude Area General Technical (GT)	1547	118.08	8.52	061	-033	070	038	047	-037	-046	372
ACB Tests											
Reading and Vocabulary (RV)	1547	122.33	10.90	049	-041	068	020	019	-051	-052	239
Arithmetic Reasoning (AR)	1547	116.00	10.43	048	-006	042	045	061	-003	-017	360
Pattern Analysis (PA)	1545	120.69	13.39	133	171	111	055	009	138	103	230
Mechanical Aptitude (MA)	1540	117.81	14.03	149	225	027	022	010	175	107	260
Army Clerical Speed (ACS)	1534	105.00	15.14	050	-004	058	042	072	001	-032	055
Army Radio Code (ARC)	1604	106.94	22.31	099	073	077	054	062	097	088	131
Shop Mechanics (SM)	1539	116.11	14.02	125	149	086	011	087	132	077	256
Automotive Information (AI)	1541	116.20	16.09	111	207	-018	051	054	160	122	237
Electrical Information (EI)	1604	109.44	16.84	063	-003	051	048	043	008	018	274
Radio Information (RI)	1604	102.98	18.00	028	-025	045	-051	-035	-010	045	187
Others											
General Information Test (GIT)	349	86.67	8.11	113	177	018	117	087	162	098	314
Electrical and Radio Information	434	32.19	6.98	053	132	-073	035	028	-040	-149	067

[a] Decimal points omitted.

Inspection of the validity of the nontest background variables (age, education, rank, and flying experience) across the different criteria demonstrated the difficulty of establishing standards which can be consistently related to multiple criteria. On the one hand, the Army wants students who have aptitude for flying and on the other hand, the Army wants students who will make good leaders. In any heterogeneous population, there must of necessity be persons who have aptitude for flying but who do not have the desired leadership qualities and vice versa. Selection standards are designed in effect to screen out these two types of person. From the combined effects of nontest standards and the administration of a test battery, a student population emerges which can be described in terms of characteristics which may be of interest to both management and the psychometrician. In advance of this research it was decided that four such variables of interest would be age, education, rank, and flying experience. The major tendency in the results is for the validity of these measures to cancel each other out when considered across criteria. The younger students tend to be better pilots while the older students tend to be better leaders. In the case of education, the relationships are very low against all criteria, but there is a slight tendency in the direction of a positive relationship with non-flying performance and a negative relationship with flying performance. Rank tends to be positively related to leadership and negatively related to flying. Flying experience tends to be positively related to flight and academic criteria but negatively related to leadership.

Although a few of the validity coefficients are fairly high, it must nevertheless be concluded that these particular variables are ineffective as predictors. From a management point of view, the results seem to indicate that an overly restrictive policy with respect to nontest selection standards would not be desirable. Thus, if the eligible group were restricted to a younger age range, the effect may be better flyers but poorer leaders.

Predictor Variables. To the extent that data were available, correlation coefficients were computed between each predictor and the three critical attrition criteria: pass-fail total, pass-fail flying, and pass-fail preflight. Where appropriate, validity coefficients were computed separately for the exploratory phases of the study and for the final validation phase. In the case of self-description measures, intermediate results based primarily on the cross-validation of certain item analysis keys were also computed.

The best psychomotor tests (Table 5) are extremely effective in predicting pass-fail flying, but these same tests tend to be ineffective in predicting pass-fail preflight (leadership). The same general pattern applies to the best tests in the effective content areas of Space, Mechanical, and Aviation Information (Table 6) with this difference: the best of these cognitive tests are not quite as effective in predicting pass-fail flying as the psychomotor tests, but equal or approach the best psychomotor tests in predicting pass-fail total.

Table 5

VALIDITY OF PSYCHOMOTOR TESTS

Test	N	Mean	S.D.	Criteria: Total	Criteria: Pass-Fail Flying	Criteria: Pass-Fail Preflight
Exploratory Phase						
Complex Coordination	477	49.91	9.99	.309	.544	.119
Direction Control	300	11.14	5.76	.207	.183	.170
Machine Identification[a]	792	1.51	.50	-.028	-.046	.051
Rotary Pursuit	477	16.32	6.08	.319	.387	.219
Rudder Control	477	43.05	11.66	.331	.518	.090
Final Validation Phase						
Complex Coordination	646	49.28	9.96	.274	.455	.143
Rotary Pursuit	645	16.55	6.51	.186	.274	.080
Rudder Control	644	43.36	10.78	.229	.447	.051

[a]See Appendix A.

Table 6

VALIDITY OF COGNITIVE TESTS IN EFFECTIVE CONTENT AREAS

Tests	N	Mean	S.D.	Criteria Total	Pass-Fail Flying	Preflight
Exploratory Phase						
Spatial						
Complex Movements	295	27.93	9.24	.279	.231	.156
Locations - Light	310	14.53	3.42	.240	---	---
Dark	444	14.63	3.43	.379	.387	.230
Total	444	29.03	6.22	.325	.385	.148
Stick and Rudder Orientation	295	22.53	9.67	.239	.342	.057
Mechanical						
Mechanical Ability	295	47.81	11.16	.139	.200	.069
Mechanical Knowledge	449	35.81	6.43	.140	.154	.063
Mechanical Principles	449	47.46	10.99	.126	.213	.022
Aviation Information						
Aeronautical Information	139	5.57	4.73	.190	---	---
Flying Information	295	23.13	11.73	.084	.176	-.012
Helicopter Information	203	44.49	13.67	.120	.233	.036
Final Validation Phase						
Spatial						
Aircraft Orientation	765	7.73	5.66	.258	.282	.131
Complex Movements	162	28.89	8.96	.342	.194	.271
Flight Visualization	765	6.39	7.52	.276	.340	.148
Instrument Comprehension	763	16.53	6.55	.267	.248	.170
Spatial Orientation	765	16.83	10.99	.292	.324	.177
Stick and Rudder Orientation	765	13.84	10.57	.279	.359	.135
Locations - Dark	162	14.69	4.03	.018	.036	.024
Locations - Total.	162	28.98	7.18	.056	.126	.053
Mechanical						
Mechanical Ability	765	36.32	8.03	.210	.350	.012
Mechanical Functions	765	12.24	7.60	.299	.390	.155
Mechanical Principles	366	12.13	5.75	.161	.249	.003
Aviation Information						
Flying Information	603	23.17	12.73	.257	.347	.074
Helicopter Information	764	37.02	14.82	.303	.386	.160

The best measures for predicting pass-fail preflight are the self-description instruments (Table 7). However, self-description instruments studied during the exploratory phase of the analysis tended to be considerably less effective in predicting pass-fail flying. Subsequent to the administration of the measures used in the exploratory phase, new item pools were developed and administered to school and on-the-job samples. On the basis of item analysis, new keys were constructed for a reduced pool of items and cross-validated. An intermediate analysis was then conducted utilizing the best of the keys and the SDB Infantry score (not subjected to formal item analysis). This item pool was then utilized to construct a final self-description form containing 103 scored items. The validity of this form is estimated to be high for predicting pass-fail total and pass-fail preflight, and moderate for predicting pass-fail flying.

Certain content categories proved in general to be ineffective predictors. These include visual perception, eye-hand coordination, and individual tests of situational reasoning and multiple reaction (Table 8). None of these tests predicted the pass-fail flying criterion. However, two of the twelve tests (Object Completion and Reaction to Signals) appeared quite promising with respect to the pass-fail preflight and pass-fail total criterion. Because it was not possible to obtain additional data on these tests and follow them through a final validation, it was not possible to determine whether they could make a substantial independent contribution to the validity of a selection battery. The potentiality of these tests must remain unresolved until such time as it is possible to do further research.

Among those tests which it was possible to carry through to final validation, two major sources of validity become evident. The self-description materials obtain their validity by being excellent predictors of preflight success. The cognitive variables obtain their validity by being excellent predictors of flying success. When measures of both kinds are incorporated into a battery on the basis of test selection procedures, the net effect is to provide an optimal balance of success factors for reducing attrition due to preflight failure and flying deficiency.

Table 7

VALIDITY OF PERSONALITY MEASURES

Tests	N	Mean	S.D.	Criteria Total r	Pass-Fail Flying r	Preflight r
Exploratory Phase						
Psychiatric Evaluation (ARMA)	185	183.44	4.13	.182	.169	.177
Qualification Report (OCE-4) (OLR-1)	446	120.57	17.01	.045	-.103	.116
Board Interview (OCI-4) (OLB-1)	445	29.79	6.27	.110	.040	.135
Leadership Composite	445	90.28	10.68	.094	-.062	.167
Background Inventory	154	10.40	3.11	.263	.272	.198
OCB-5 Background	256	5.06	2.26	.211	.094	.211
Leadership	256	98.82	6.85	.211	.077	.253
Resignation	256	37.89	4.43	.224	-.035	.351
OCB-6	256	46.45	4.88	.229	.195	.210
Army Self-Description Blank (Recruit)						
SDB - Driver	256	14.66	2.20	.151	.132	.132
Infantry[a]	256	88.77	8.63	.295	.147	.324
Leadership	256	44.87	6.76	.246	.168	.263
Mechanic	256	39.89	4.09	.224	.231	.169
Intermediate Phase						
SDB - Infantry[a]	162	83.09	8.93	.420	.313	.144
SDB - 20 items	162	13.21	2.50	.349	.511	.198
SDB - 49 items	603	33.87	4.54	.259	.024	.311
Final Validation Phase						
Qualification Report	758	113.66	22.06	.097	.071	.049
Board Interview	758	27.65	6.59	.130	-.006	.131
Leadership Composite	758	84.76	15.14	.137	.053	.126
SDB - 103 items	458	71.93	8.63	.361	.211	.326

[a]Helicopter Pilot Description Form.

Table 8

VALIDITY OF COGNITIVE TESTS IN INEFFECTIVE CONTENT AREAS

Tests	N		S.D.	Criteria Total r	Pass-Fail Flying r	 Preflight r
Visual Perception						
Attention to Detail	256	30.49	6.65	.000	-.111	.075
Dials	256	35.74	7.71	.175	.182	.138
Object Completion	102	38.41	4.70	.336	.202	.321
Perceptual Speed II	256	30.74	6.25	.145	.101	.194
Reaction to Signals	102	111.24	25.11	.366	.094	.473
Related Forms	256	59.19	13.22	.148	.192	.085
Eye-Hand Coordination						
Aiming	449	110.36	15.65	.113	.001	.198
Patterns	611	61.94	13.48	.176	.204	.102
Tapping	449	133.22	20.92	.121	.199	.086
Two-Hand Coordination	255	134.58	23.82	.154	.168	.103
Situational Reasoning	[illegible]	13.54	4.36	.123	.025	.049
Multiple Reaction	295	-----	----	.140[a]	.078[a]	.116[a]

[a]Average of 11 subtests.

CONSTITUTION OF THE FLIGHT APTITUDE SELECTION TESTS (FAST)

Four major prediction problems are involved in selecting personnel for Army pilot training:

1. Predicting the success of enlisted personnel in preflight and rotary-wing training.

2. Predicting the success of enlisted personnel in preflight and fixed-wing training.

3. Predicting the success of officer personnel in rotary-wing training.

4. Predicting the success of officer personnel in fixed-wing training.

A comprehensive selection testing program would provide solutions for all four problems. Army research between 1955-1963 provided solutions to problems 1 and 4, but not to problems 2 and 3. When, in 1963, DCSPER directed that a comprehensive program be developed, it was decided that a viable program could be developed by supplementing available data with expert judgment. A sufficient body of research experience in pilot trainee selection existed to provide reasonable assurance that a valid comprehensive program could be made operational without extensive prior experimental research. This decision does not preclude further research. But it was felt that the most profitable approach to future research would be to analyze follow-up data collected under the comprehensive program, rather than to hold up implementation pending the collection of experimental data.

The basic assumptions in developing the comprehensive program were that (1) since there were four different selection problems, maximum validity for solving all four could be obtained by having four different test composites, and (2) since there were common elements across problems, there should be some overlap of tests across test composites. It was decided that all four composites would follow a common pattern: they would be paper-and-pencil measures, and each composite would have at least one test in each of the content areas of aviation information, mechanical, personality, and spatial.

The common elements in solving problems 1 and 2 are enlisted personnel and preflight training; the appropriate common test elements are personality measures.

The common element in solving problems 3 and 4 is officer personnel; the appropriate common test elements are also personality measures.

The common element in solving problems 1 and 3 is rotary-wing training; the appropriate common test elements are cognitive tests demonstrated to be valid for rotary-wing selection.

The common element in solving problems 2 and 4 is fixed-wing training; the appropriate common test elements are cognitive tests demonstrated to be valid for fixed-wing selection.

The tests finally selected to form the four composites (Figure 3) appear to be highly satisfactory with respect to the validity of each composite and to appropriate inclusion of common test elements. Analysis of operational data can provide a basis for refinements to sharpen the differential effectiveness of the various composites.

Validity of the FAST Batteries

The validity of the FAST batteries was estimated by analysis of all available research and operational data on rotary-wing and fixed-wing tests, including both Army and Air Force results. Raw score means, standard deviations, and validity coefficients for each test and for each composite were computed against the pass-fail total criterion, and intercorrelation matrices were constructed (Appendix C).

Table 9 summarizes the bulk of what has been accomplished in APRO's long-range research effort culminating in the FAST batteries. In the officer area, an effective fixed-wing battery has been supplemented by an equally effective rotary-wing battery. In the Warrant Officer Candidate area, a rotary-wing battery has been developed which is superior in validity to the previous interim operational battery, with particularly marked improvement in predicting the pass-fail flying criterion, and an equally effective fixed-wing battery, not previously available for enlisted applicants, has been developed.

In addition to the absolute gains in validity demonstrated in Table 9, the provision for obtaining both a rotary-wing score and a fixed-wing score for each individual tested could result in further increasing the effectiveness of each composite.

Table 9

COMPARISON OF VALIDITY COEFFICIENTS: FAST BATTERIES VS INTERIM AND PROTOTYPE BATTERIES

	Pass-Fail Total r	Pass-Fail Flying r
Officer Batteries		
Proposed FAST Batteries		
Rotary-Wing	.42	
Fixed-Wing	.39	
Interim Operational Batteries		
No Rotary-Wing Battery	---	
Fixed-Wing		
AFWAB-1	.41	.32
AFWAB-2	.39	
Warrant Officer Candidate Batteries		
Proposed FAST Batteries		
Rotary-Wing	.48	.47
Fixed-Wing	.46	
Interim Operational Batteries		
Rotary-Wing		
1st Interim (2-Test) Battery	.14	.05
2d Interim (4-Test) Battery	.21	.17
3rd Interim (ARWAB-1) Battery	.44	.30
No Fixed-Wing Battery	---	
Prototype Rotary-Wing Batteries		
Mobilization	.46	.54
Peacetime	.45	.43
Core	.37	.40

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APPENDIXES

APPENDIX A

VARIABLES USED IN ROTARY-WING RESEARCH

CRITERIA

PASS-FAIL TOTAL (PFT)

This criterion measure dichotomized students as passing versus failing the helicopter pilot training course. Passing was defined as graduating from the course. Failures were men who began the course but did not graduate, except for those required to discontinue training because of medical deficiencies (10 to 15 percent) or compassionate releases (about 1 percent). Pass-fail represents an administrative action by a board. At the same time, it presumably reflects the board's evaluation of performance as acceptable or unacceptable.

The official reasons for failing a student fell into two main categories. Lack of motivation applied to failures in the preflight phase and indicated that the student voluntarily withdrew from training for a variety of reasons--he was doing poorly, he had broken training regulations, he couldn't "take" the training, etc. A second reason, flying deficiency, generally associated with the presolo phase of training, indicated that the student lacked abilities necessary to be a good helicopter pilot. A few failures were due to academic deficiency, lack of leadership, and conduct unbecoming a Warrant Officer.

The final decision to fail a student was made following a personal interview by a review board of officers composed of the company commander, company officers, and a medical officer. All pertinent records and recommendations by cadre, instructor pilots, and military check pilots were reviewed.

PASS VS. FAIL DUE TO FLYING DEFICIENCY (PFF)

The decision to fail a student was made by a board of officers on recommendation of the student's instructor and on review of the flight record. When flight grades were reviewed, it was decided either to fail or to grant additional dual training periods in preparation for another check ride. In the official papers prepared to support elimination from training, a tabulation of the number of S (Satisfactory), U (Unsatisfactory), and D (Dangerous) flight period grades and the total amount of flight training was provided. Performance relative to the amount of training as well as the absolute frequencies were considered although percentages and/or weighted sums of averages were not computed. The reviewing boards strive to provide "slow starters" with sufficient opportunity and yet avoid unnecessary expenditure of flight training time. The high cost of flight training and the student-instructor ratio (which varied from 2 to 6)

placed considerable pressure on the board to eliminate poor students as early as possible. Most flying deficiency attrition occurred at the end of the presolo stage--that is, on failure to pass the presolo check ride, sometimes after several attempts to do so, sometimes after one attempt following generally poor performance.

Because multiple reasons for elimination were often given in the official papers and a primary reason was not always provided, the following conditions were imposed to insure that only clear cases of flying deficiency were included in the failure group: a) "Flying Deficiency" was explicitly included among the administrative statements listing reasons for elimination from training; b) the flight record book showed some graded flight time; and c) the instructor's practical flight grade was given and was less than 70%, i.e., failing.

PASS-FAIL PREFLIGHT (PFP)

Preflight training is a separate four-week phase of training designed to weed out leadership failures prior to flight training. Attrition during the early phase was generally attributed to deficiencies in leadership ability, conduct, attitudes, and motivation.

Since all enlisted graduates receive a Warrant Officer rating, leadership training is an important aspect of the course. Classes prior to class 56-8 were given this training concurrent with flight training. However, it was felt that leadership training (with its resulting attrition) given before the expensive flight training would be advantageous. Consequently, beginning in February 1956, a four-week preflight phase was initiated. The passing group consisted of those students who completed preflight training; the failing group consisted of those trainees who failed to complete preflight training for any reason.

PERCENT OF PRESOLO SATISFACTORY FLIGHTS

The percentage of satisfactory grades received for the presolo stage was used as a continuous measure that would not only highly reflect the dichotomous attrition variable (Pass vs. Fail due to flying), but one that would more likely exclude "non-flying skill" variance. This is believed to be so because only graded flights enter into the determination of this measure. (Of course, this is true only to the extent that the instructor is able to grade the student strictly on his ability to perform designated flight maneuvers.)

2D + U PRESOLO FLIGHTS

The composite of twice the number of dangerous grades plus the number of unsatisfactory flight grades received was used as a continuous criterion measure.

PRACTICAL FLIGHT GRADE

This was a grade given by the instructor pilot to a graduating student based on a review of the student's flight record. It was not a computed score, as were all other grades, but rather an overall rating on a percentage scale (with the traditional use of 70 percent to represent passing performance).

FINAL FLIGHT GRADE

This grade was a weighted average of the practical flight grade and a score on two written tests governing knowledge specific to flight technique. Written test performance was arbitrarily given a weight of 1/3 in the final flight grade.

ACADEMIC GRADE

Academic classroom training, covering various aspects of helicopter flight and maintenance, is provided concurrently with flight training. Although very few students are eliminated for academic deficiency, academic grades are used in arriving at an end-of-course final course grade. Scores on 19 classroom examinations were averaged to arrive at the academic grade for graduating students.

FINAL COURSE GRADE

This overall grade is the average of the final flight grade and the academic grade with each given equal weight.

ACADEMIC RANK

For classes at Fort Rucker, this measure was a ranking based on final academic grade, with ranks equated for size of class. Size of class was considered as equal to the number of individuals graduating with the class. For classes at Camp Wolters, the measure was the ranking "flight academic standing", also equated for size of class.

LEADERSHIP RANKINGS

At periodic intervals throughout the training period, each student prepared an "order of merit rating sheet" on which he ranked all students within his platoon from best to poorest on Warrant Officer candidate potential. The student rater was instructed to "consider and evaluate the candidate concerning force, attitude, and dependability, but in no way should the rater limit himself to the consideration of these traits alone. The rater will consider all traits essential in a candidate to

qualify himself for commission...". Similar ratings were obtained from tactical officers. Average peer rankings and average tactical officer rankings were converted separately to percentile scores and then combined, peer rankings being double weighted. The procedure was carried out separately for each class; scores from class to class were arbitrarily defined as equivalent. Only the graduating students were used in relating predictors to leadership ratings. During the 7th week, each student in the sample was rated by 9 to 27 classmates; in the later weeks of training the range in the number of raters was lower.

Rankings were designated as WOC-1, WOC-2, WOC-3, depending upon the time of rating. WOC-1 ratings were obtained at the end of the seventh week of training. WOC-2 ratings were obtained at the end of 14 weeks of training. For classes 57-1 through 57-4 which completed training at Fort Rucker, Alabama, WOC-3 ratings were obtained at the end of 21 weeks of training. For later classes, trained at Camp Wolters, Texas, WOC-3 ratings were obtained from peers at the end of 18 weeks of training and from tactical officers at the end of 20 weeks of training. Data from Camp Wolters were combined with data from Camp Rucker.

ON-THE-JOB RATINGS

Operational units were visited in 1958 and on-the-job ratings were obtained. Each pilot rated each of the pilots in his squad for his flying proficiency, his performance on "non-flying" duties, and finally by the overall rating. A combination ranking and rating procedure was actually used in which the pilots were first ranked in their squad. After the ranking had been accomplished, a rating was then applied based on seven descriptive categories. Forced agreement was made between rankings and ratings. Only the average over-all rating for each pilot was used in the analysis. The seven descriptive categories were as follows:

RATING	DESCRIPTION OF PERFORMANCE TO EARN THIS RATING
7	A MOST OUTSTANDING WARRANT OFFICER PILOT. He excels nearly all other officers in the performance of his duties. One of the exceptional Warrant Officer pilots who should be considered for more rapid advancement than his contemporaries.
6	AN EXCELLENT WARRANT OFFICER PILOT. He performs his duties in a manner far above that of the average Warrant Officer pilot. He should be considered as early as possible for advancement.
5	AN ABOVE AVERAGE WARRANT OFFICER PILOT OF DISTINCT VALUE TO THE SERVICE. He performs his duties in a highly satisfactory manner. He deserves advancement before most other Warrant Officer pilots.
4	A COMPETENT, DEPENDABLE WARRANT OFFICER PILOT. He performs his duties in a manner similar to most other Warrant Officer pilots. He should be considered for advancement.

3 <u>A FAIRLY ABLE WARRANT OFFICER PILOT</u>. He performs his duties in an acceptable but routine manner. Although he may be considered for advancement, many other Warrant Officer pilots should be considered before him.

2 <u>A WARRANT OFFICER PILOT WHO PERFORMS ACCEPTABLY IN A LIMITED RANGE OF ASSIGNMENTS, BUT WHO COULD EASILY BE REPLACED</u>. He is barely adequate in the performance of his duties. He should be advanced only after most other Warrant Officer pilots.

1 <u>AN UNSATISFACTORY WARRANT OFFICER PILOT OF LITTLE VALUE TO THE SERVICE</u>. Not of the caliber one should reasonably expect in an officer. He performs his duties in an inadequate manner. He should not be advanced.

BACKGROUND VARIABLES

AGE

Age to nearest year upon entering helicopter school training.

EDUCATION

Civilian education in years.

RANK

Rank--coded 1 (1 = E-1) to 7 (7 = E-7) upon entering helicopter school training.

PREVIOUS FLYING EXPERIENCE

Previous flying experience in two categories: no time - category 0; 1 or more hours = category 1.

REFERENCE VARIABLES

GENERAL TECHNICAL APTITUDE AREA

Aptitude Area GT, used in selecting trainees for the course, was derived from two ACB test scores (composite of scores on the Reading and Vocabulary and Arithmetic Reasoning Tests).

ARMY CLASSIFICATION BATTERY (ACB) TESTS

- Reading and Vocabulary (RV)
- Arithmetic Reasoning (AR)
- Pattern Analysis (PA)
- Mechanical Aptitude (MA)
- Army Clerical Speed (ACS)
- Army Radio Code (ARC)
- Shop Mechanics (SM)
- Automotive Information (AI)
- Electrical Information (EI)
- Radio Information (RI)

ARMY ELECTRICAL AND RADIO INFORMATION, DA PRT 2904

The first part of the test contains 22 items requiring the examinee to select the one of four pictures of electrical equipment which is most like or which belongs with a fifth picture. The second part is composed of 20 four-choice completion items relating to electrical and radio information. Testing time is 15 minutes. Score is number Right.

GENERAL INFORMATION TEST, GIT, PT 2839

A test designed to measure interest in masculine-type outdoor activities (including military matters) by tapping knowledge that would presumably have been gained almost entirely by actual participation. There are 100 "positive" type items, and 20 "negative" or suppressor type items tapping a "bookworm" or dilettante component. In the initial research three scores were obtained: positive key alone, negative key alone, and total or positive key minus negative key.

PSYCHOMOTOR

COMPLEX COORDINATION TEST, CCT

The examinee is presented with double rows of lights (one red row and one green row) in the approximate pattern of an "N" on its side. One red light in each row is lit. The examinee is required to match the position of a stimulus light in each of three dimensions by adjustments of the stick and rudder controls. After each matching, a new pattern of red lights is presented, and the examinee must reproduce this pattern with the green lights. The total score was used as the criterion variable. Following analysis of trend scores, raw scores were corrected to T-scores with a mean of 50 and an SD of 10. Total score is number of completed matchings. Testing time is 8 minutes.

DIRECTION CONTROL TEST

The examinee manipulates a learned combination of switches and buttons as rapidly as possible in response to a series of visual patterns differing from one another with respect to the spatial arrangement of their component parts. Testing time is 8 minutes. Score is number of patterns successfully completed.

MACHINE IDENTIFICATION

Two pieces of apparatus were used for each of four psychomotor tests--Complex Coordination, Direction Control, Rotary Pursuit, and Rudder Control. Although each copy of any one psychomotor test was constructed to be equal to the other, the possibility that they were in fact different was tested. One copy of each test was identified as Machine A and the second copy as Machine B. Within any one class an equal number of different examinees were assigned at random to Apparatus A and B. All examinees tested with Apparatus A for any test were the same examinees tested with Apparatus A for all other tests; the same was true for examinees tested with Apparatus B. Analysis of variance was conducted to determine whether there were significant mean differences or significant interaction effects due to the use of different copies of each apparatus test.[1]

For purposes of computing correlation coefficients, examinees were assigned a value of 1 or 2 depending on whether they were administered Apparatus A or Apparatus B. Correlation coefficients between the copy of the apparatus used (A or B) and the criterion variables (Pass-Fail Total, Pass-Fail Flying, and Pass-Fail Preflight) indicate the extent to which random selection of individuals to Machine A or Machine B resulted in inadvertent bias with respect to the criterion scores of the individuals selected.

ROTARY PURSUIT TEST, RPT

The examinee is required to keep a prod-stylus in contact with a small metallic disk set into a larger disk revolving at 6 rpm. The sum of contact time over three trials was used as the total score. Testing consists of three 20-second trials.

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[1] Dobbins, D. A., Martinek, H., and Anderson, A. A. Inter- and intra-apparatus variance of psychomotor test scores of Army helicopter pilot trainees. Research Memorandum 61-5. May 1961.

RUDDER CONTROL TEST, RCT

The examinee sits in a mock cockpit which his own weight throws off balance unless he applies the proper correction by means of foot pedal controls. His task is to keep the cockpit lined up with one of three target lights located on a panel before him. Testing consists of one 90-second central target trial and one 348-second triple-target trial. The sum of both trials was used as the total score.

PERSONALITY AND LEADERSHIP

PSYCHIATRIC EVALUATIONS

Adaptability Rating of Military Aviation (ARMA). This is a four-category rating provided by the psychiatrists at the Aviation School. Initially, a 20-point rating ranging from 51 to 170 was used with the categories of "passed," "marginal," "borderline," and "failed." In this analysis, the mean rating for each category was used. Since this was an experimental evaluation, no students were actually eliminated from training on the basis of the evaluation. Evaluation results were not given to any of the aviation training personnel, in order to avoid bias. However, in the event a student appeared before a Proficiency Board because of poor performance, the psychiatrist who initially made the ARMA evaluation on the student was asked to give his overall assessment of the student. This same assessment was used by the Board in deciding to continue or eliminate a student.

EVALUATIONS BY SUPERVISORS

The Officer Leadership Qualification Report, OLR-1 (DA Form 6233), previously the Officer Candidate Evaluation Report, OCE-2, (DA PRT 649). This report is a form by means of which the performance of the applicant is evaluated with respect to his leadership potential. The form is completed by the immediate supervisory NCO, and endorsed by the immediate superior commissioned officer.

The Officer Leadership Board Interview, OLB-1 (DA Form 6227), previously the Officer Candidate Board Interview, OCI-4, (PT 650). The applicant is presented informally with problem situations for discussion before an Officer Candidate Interview Board composed of five officers. The manner in which the applicant handles each problem gives the Board an opportunity to observe and evaluate him in terms of self-assurance, appearance, voice control, and ability to organize ideas on other specific qualities. Board members independently evaluate the applicant; evaluations are later combined to yield a numerical index. In the second half of the Board procedure, an appraisal of the applicant on the basis of his complete record is made to determine his overall qualification for a Warrant Officer appointment. The Board then submits a recommendation to the major commander to accept or reject the applicant. The OLB-1 measure assessed in the present publication against the pass-fail criteria is the numerical index. Subjects were necessarily limited to applicants receiving Board acceptance who were later accepted into training.

Leadership Composite. A weighted combination of the Officer Candidate Evaluation Report, OCE-2 and Officer Candidate Board Interview, OCI-4 used operationally in the first interim battery. Operational weights were .5 for OCE-2 and 1.0 for OCI-4. The Leadership Composite was not computed separately for examinees who took the second and third interim batteries.

SELF-DESCRIPTION MEASURES

Activities Inventory, PT 3145. This inventory consists of 215 two-choice items in which each item represents an activity and the subject responds as follows: A if he likes the activity and B if he dislikes the activity. This instrument was used for evaluation of personality constructs and item analysis. Total Score was not computed. The items were written with 11 constructs in mind: (1) Masculine Toughness vs. Harm Avoidance, (2) Liking for Order, Neatness, System, (3) Physical Activeness, (4) Independence, Self-Reliance, Confidence, (5) Affiliation, (6) Responsibility, (7) Social Manipulative, (8) Thrill and Adventure, (9) Nurturance, (10) Ambition, and (11) Practical.

The number of items in each construct ranged from 17 items for Affiliation to 22 items for Thrill and Adventure.

Army Self-Description Blank (Recruit) DA PRT 2712. In Part I of this instrument, the examinee selects the phrase which is most descriptive and the phrase which is least descriptive of himself out of five phrases in each of 17 groups. In Parts II and III he indicates whether a sentence or phrase does or does not describe him. The Blank contains four empirical keys: Infantry, Leadership, Mechanical, and Driver. Testing time is 30 minutes.

Background Inventory, PT 3035. The 30 five-choice items of this inventory relate to the examinee's family, education, hobbies, and employment. Testing time is 10 minutes. Score is number Right.

Helicopter Pilot Description Form, HPDF-1, DA Form 6243. This test was used operationally as part of the third interim battery, ARWAB-1. It consists of the items in the Infantry Key of the Army Self-Description Blank (Recruit) DA PRT 2712. Testing time is about 20 minutes.

Helicopter Pilot Trainee Attitude Questionnaire, PT 3147. This inventory consists of 74 four-choice items: 34 items in Section I, 22 items in Section II, and 18 items in Section III. Section I contains statements of attitudes toward the Army, helicopter training, and military service in general. The examinee indicates his agreement or disagreement to each statement on a four-choice scale, and there is no undecided category. Section II contains reasons of positive appeal for entering helicopter training, and the examinee indicates the extent to which the statement was a consideration in influencing him. Section III contains reasons of negative appeal for entering helicopter training and the examinee

indicates the extent to which the statement was a consideration in influencing him. This instrument was used for evaluation of personality constructs and item analysis. Total score was not computed.

The items were written with three constructs in mind: (1) Army life attitude, 38 items; (2) Warrant Officer aspiration, 9 items; and (3) flying attitude, 15 items.

Officer Biographical Information Blank (OCB-6), PRT 2480. This questionnaire contains a total of 80 pairs of forced-choice items. Forty-five pairs were self-description items, and fourteen pairs were self-estimates-of-ability items.

Officer Candidate Biographical Information Blank (OCB-5), PRT 2463. A self-description questionnaire containing 30 five-choice biographical data items, and 300 yes-no self-description and personal characteristics items. Three empirical keys derived in other studies--a background key based on the biographical items, a leadership key on the yes-no items, and an empirical resignation key--were analyzed.

Personal Description Inventory, PT 3159. This inventory consists of 198 two-choice items: 162 items in Part I and 36 items in Part II. The items in Part I require the examinee to mark "A" for statements that describe him, and to mark "B" for statements that do not describe him. The items in Part II consist of forced-choice pairs of statements; the examinee is to choose the statement (A or B) which best describes him. This instrument was used for evaluation of personality constructs and item analysis. Total score was not computed.

The items in Part I were written with seven constructs in mind: (1) Activity Level, (2) Self-Confidence, (3) Distractibility and Indecisiveness, (4) Masculinity, (5) Self-Reliance, Independence, (6) Interpersonal Relations, and (7) Social Responsibility.

The items in Part II were written with four constructs in mind: (1) Sociability, (2) Responsibility, (3) Emotional Stability, and (4) Ascendancy.

The number of items in the constructs for Part I range from 21 for Self-Confidence to 26 for Masculinity. The four constructs in Part II each contained 18 items.

Personal History Form, PT 3161. This 211-item background inventory consists of 18 items in Part I and 193 items in Part II. Part I deals with family structure, unusual family circumstances, financial status, education, and father's occupation. Part II deals with high school jobs performed, geographical areas of the country lived in, size of community lived in, food served at home and food preferences, childhood and adolescent

diseases and injuries, family ownership and use of recreational or hobby equipment, membership in various clubs and organizations, participation in sports, school subjects studied, entertainment activities such as attending movies or playing cards, and skill with various tools and implements. This instrument was used for evaluation of personality contructs. Total score was not computed.

Self-Description Blank, Driver (SDB-Driver). See Army Self-Description Blank, (Recruit) DA PRT 2712.

Self-Description Blank, Infantry (SDB-Infantry). See Army Self-Description Blank, (Recruit) DA PRT 2712.

Self-Description Blank, Leadership (SDB-Leadership). See Army Self-Description Blank, (Recruit) DA PRT 2712.

Self-Description Blank, Mechanical (SDB-Mechanical). See Army Self-Description Blank, (Recruit) DA PRT 2712.

Self-Description Form - Final: (a) SDB - 20 items, (b) SDB - 49 items, (c) SDB - 103 items, (d) SDB - 190 items. See page 25.

COGNITIVE

SPATIAL

Aircraft Orientation Test, AOT-1 (DA Form 6237). This 28-item test is a measure of ability to visualize the relationship between an airplane and the territory over which it flies. Six black and white pictures are presented to the examinee. The first picture is the view of the pilot as he looks out over the nose of his plane; he then matches this to a picture showing an airplane and horizon (ground view). There are five alternatives; the scoring formula is Rights minus 1/4 Wrongs. Testing time is 10 minutes.

Complex Movements Test, CMT-1 (DA Form 6242). This 60-item test, previously named Coordinate Movements Test, requires the examinee to judge distances and visualize movements quickly and relate these distances and movements to a set of symbols. The test is a component of the third interim battery (ARWAB-1). The score is Rights minus 1/4 Wrongs. Testing time is 10 minutes.

Flight Visualization Test, FVT-1 (DA Form 6238). This 28-item test is a measure of ability to visualize airplane maneuvers. Six airplane silhouettes and written information are provided. On the basis of three consecutive maneuvers by written command, the examinee decides what the position of the airplane would be after the three commands. There are five alternatives; the scoring formula is Rights minus 1/4 Wrongs. Testing time is 30 minutes.

Instrument Comprehension Test, ICT-1 (PT 3124). In this 30-item test, each item consists of pictures of two instruments, an artificial horizon and a compass, followed by pictures of 5 planes. The problem is to determine which of the 5 planes has a position and direction consistent with the instrument readings. There are five alternatives; the scoring formula is Rights minus 1/4 Wrongs. Testing time is 15 minutes.

Locations Test, DA PRT 2852. This 48-item visual test consists of sets of four small photographs, each set being accompanied by a large photograph having five lettered locations marked. The examinee is required to identify the lettered location in the larger photograph from which each of the four small photographs were taken. Six of the 12 sets of four small photographs are darkened to give a "night" effect. Items are scored rights only. Each of the 24 light and dark items, as well as the items combined, are analyzed as separate variables.

Locations Test, DA Form 6240, was used operationally as part of the third interim battery (ARWAB-1). It consists of the 24 dark items only.

Spatial Orientation Test, SOT (PT 3093). This 48-item test is a measure of ability to see changes in direction and position. For each problem in the test, there are two pictures of motor boats. The examinee must determine how the position of a motor boat changes from its original position shown in the top picture to its position shown in the bottom picture. In the five alternatives, a dot stands for the aiming point and a bar stands for the boat's prow. The scoring formula is Rights minus 1/4 Wrongs. Testing time is 10 minutes.

Stick and Rudder Orientation Test, (PT 3175). This 30-item speeded test presents the examinee with three photographs taken from the cockpit of a plane doing simple maneuvers (banking, turning, climbing, and diving) or combinations of maneuvers (turning while climbing, for example). The examinee is required to relate the maneuvers shown to stick and to rudder positions on the answer sheet. The scoring formula is Rights minus 1/4 Wrongs. Testing time is 10 minutes.

MECHANICAL

Mechanical Ability Test, PT 3118. The first part of the test consists of 30 four-choice items largely relating to automotive equipment and functions. The second part consists of 20 four-choice items requiring the examinee to solve practical mechanical problems. Testing time is 30 minutes. Scoring formula is Rights minus 1/3 Wrongs.

Mechanical Ability Test, Form 2, MAT-2 (PT 3129). This 50-item test is a measure of knowledge about general mechanics (Part I - 30 items) and tool functions (Part II - 20 items). The statements about general mechanics are for the most part information-type items about automotive and other mechanical objects. In Part II, pictures and tools are presented and the examinee identifies their use. There are four alternatives; the scoring formula is Rights minus 1/3 Wrongs. Testing time is 25 minutes.

Mechanical Functions Test, MFT-1 (PT 3189). This 34-item test is a measure of ability to understand general mechanical principles. Pictures are shown and questions are asked on the mechanical principles illustrated. The pictures are of practical real life situations. There are two alternatives; the scoring formula is Rights minus Wrongs. Testing time is 15 minutes.

Mechanical Knowledge (MK-1),--Navy Test. This test requires the examinee to select the one of four pictures of tools which is associated with the fifth picture. The 40 sets of pictures represent tools used in various trades, e.g., carpenter, machinist, plumber, etc. Testing time is 10 minutes. Scoring formula is Rights minus 1/3 Wrongs.

Mechanical Principles Test, MPT-1 (DA Form 6236). This 30-item test requires the examinee to solve problems on the basis of principles of mechanics. Diagrams are shown and questions asked on the mechanical principles illustrated. The diagrams tend to be somewhat abstract in nature. There are five alternatives; the scoring formula is Rights minus 1/4 Wrongs. Testing time is 30 minutes.

AVIATION INFORMATION

Aeronautical Information Test, DA PRT 3036. The 30 five-choice items of this test related to general and technical aspects of fixed-wing aviation, e.g., flying terminology, specific maneuvers, use of controls, etc. Testing time is 20 minutes. Score is number right.

Flying Information Test, FIT-1 (PT 3209). This 70-item test is a measure of general and technical knowledge of aviation. Most of the statements require knowledge needed in handling an airplane. There are four alternatives; the scoring formula is Rights minus 1/3 Wrongs. Testing time is 50 minutes.

Helicopter Information Test, HIT (PT 3224). The 85 items of this test relate to the flying, uses, terminology, and theory of the helicopter. There are four alternatives; the scoring formula is Rights minus 1/3 Wrongs. Testing time is 20 minutes.

Helicopter Information Test, HIT-1, DA Form 6241. This 32-item test is a component of the third interim battery, ARWAB-1. These 32 items were the most valid of 65 conventional information-type items of the original 85-item test (20 were picture items). The test relates to the flying, uses, terminology, and theory of the helicopter. The scoring formula is Rights minus 1/3 Wrongs. Testing time is 20 minutes.

VISUAL PRECEPTION

Attention to Detail Test, DA PRT 2613. This is a 60-item four-minute, hand-scored perceptual speed test of the "C-Cancellation" type. The examinee counts the C's in a row of O's. Scored Rights only.

Dials Test, DA PRT 2786. This two-part, 60-item perceptual speed test requires the examinee to detect which one of four dial readings is in a danger zone as shown by shaded areas in four corresponding master dials. Part I receives 2 1/2 minutes of test time; Part II receives 2 minutes of test time. Scored Rights only.

Object Completion Test, DA PRT 2853. This five-part, 75-item visual test requires the examinee to recognize line drawings of military objects through checkered masks concealing 75%, 90%, 75%, 90%, and 75% of each picture in the respective parts. Scored Rights only for the total of Parts III, IV, and V (45 items).

Army Perceptual Speed Test, Form 2, DA PRT 2644. This is a 48-item, five-minute test printed directly on the machine-scored answer sheet. Each set of four items requires the examinee to match four groups of sketched objects with the proper four of five sketch groups from which they are taken. Scored Rights only.

Reaction to Signals Test, DA PRT 2353. This is a two-part, 210-item test of coding speed requiring the examinee to mark predesignated combinations of answer spaces for each item, according to a geometrical code signal (e.g., triangle means to mark A, B, and C). Part I receives one minute of practice and four minutes of test time; Part II receives two minutes of practice and four minutes of test time. In scoring, each answer space is regarded as an item, and the score is 1/3 Rights minus 1/3 Wrongs with the result divided by three. In this scoring, the maximum possible number of correct answer space markings is 530.

Related Forms Test, DA PRT 2855. This is an 84-item, nonverbal reasoning test printed directly on the machine-scored answer sheet. In 28 groups of three items each, it requires the classification of each item (a geometrical pattern) in Type A or Type B according to a set of model patterns with each of the 28 groups having its own set of Type A and Type B model patterns. Scored Rights minus Wrongs.

EYE-HAND COORDINATION

Aiming Test, DA PRT 3074. The examinee is required to make one dot in each of many circles, 1/8 inch in diameter, working as fast and accurately as possible. Testing time is 30 seconds. Score is number of circles dotted correctly, i.e., within or on perimeter.

Patterns Test, DA PRT 2788. The examinee is required to reproduce on an answer sheet a line pattern which conforms to a pattern presented in a different part of the answer sheet. Score is number of correct answer spaces filled.

Tapping Test, DA PRT 3072. The examinee is required to make three dots in each of many circles 1/2 inch in diameter, working as fast and accurately as possible. Testing time is 2 minutes. Score is number of circles dotted correctly, i.e., within or on perimeter.

Two-Hand Coordination Test, DA PRT 2617. This eye-hand coordination test requires the examinee to place a stylus point in successive circles on the test sheet with each hand, moving left hand and right hand alternately in three timed parts of 25 seconds each. The score is the number of circles having one clear stylus mark inside or touching the circle.

COGNITIVE CONTENT AREAS MEASURED BY SINGLE TESTS

Situational Reasoning Test, SRT-1, (DA Form 6206). This 30-item test measures ability to solve practical judgment type problems. The examinee is asked to select the most practical solution for military and non-military problem situations. Half of the items were adapted from a previous Air Force test used in fixed-wing pilot selection. There are four alternatives; the scoring formula is Rights minus 1/3 Wrongs. Testing time is 20 minutes.

Multiple Reaction Test, MRT-1 (DA PRT 3192). Printed tasks are interspersed with tasks given by tape recorder. Tests include dial interpretations, code reaction, and attention span. The test measures the ability of the examinee to perform a variety of tasks and to adapt to rapidly changing situations and instructions. Eleven part scores were computed for each individual.

APPENDIX B

VALIDITY COEFFICIENTS, MEANS, STANDARD DEVIATIONS, AND INTERCORRELATIONS FOR PREDICTOR VARIABLES IN MODEL ROTARY-WING BATTERIES

Table B-1

VALIDITY COEFFICIENTS FOR ROTARY-WING PREDICTORS USED IN FINAL VALIDATION

	Variable Number	Samples IV',IV'',V Pass-Fail		Samples IV',IV'' Pass-Fail		Sample V Pass-Fail		Samples IV'',V Pass-Fail		Sample Ac 7 Pass-Fail	
		Total	Flying	Total	Flying	Total	Flying	Total	Flying	Total	Flying
Psychomotor Tests											
Complex Coordination	144	274[a]	455	257	446	349	488	273	420	321	695
Rotary Pursuit	136	186	274	207	289	092	221	140	213	195	422
Rudder Control	139	229	447	237	373	194	710	242	540	348	691
Personality and Leadership Measures											
Self-Description (103 items)	SDB	361	211	307	038	460	505	351	325	374	042
Qualification Report (OCE-2/OLR-1)	205a	097	071	102	044	078	163	121	139	-120	-188
Board Interview (OCI-4/OLB-1)	206a	130	-006	086	-022	301	051	204	-026	087	181
Cognitive Tests											
Spatial Content Area											
Aircraft Orientation	150	258	282	257	337	263	096	197	216	525	679
Complex Movements	148	342	194								
Flight Visualization	151	276	340	286	377	240	215	235	310	611	681
Instrument Comprehension	152	257	248	262	246	285	257	236	224	401	656
Locations - Dark	121	018	036								
Locations - Total	122	056	126								
Spatial Orientation	154	292	324	279	381	338	132	283	269	494	688
Stick and Rudder Orientation	147	279	359	297	424	212	139	279	286	539	749
Mechanical Content Area											
Mechanical Ability, Form 2	157	210	350	250	338	062	388	172	410	289	370
Mechanical Functions	153	299	390	336	459	163	155	301	370	342	457
Mechanical Principles	159	161	249								
Aviation Information Content Area											
Flying Information	146	257	347								
Helicopter Information	149	303	386	363	393	083	362	246	318	557	71[illegible]
Situational Reasoning Content Area											
Situational Reasoning	158	123	025								

[a]Decimal points omitted.

Table B-2

N's, MEANS, AND STANDARD DEVIATIONS OF ROTARY-WING PREDICTORS USED IN FINAL VALIDATION

	Variable Number	Samples IV',IV'',V N	Means	S.D.	Samples IV',IV'' N	Means	S.D.	Sample V N	Means	S.D.	Samples IV'',V N	Means	S.D.	Sample Ac 7 N	Means	S.D.
Psychomotor Tests																
Complex Coordination	144	646	49.28	9.957	525	49.15	9.853	129	47.14	10.371	341	47.86	9.947	176	33.64	10.134
Rotary Pursuit	136	645	16.55	6.511	524	16.70	6.535	129	17.68	6.414	340	17.16	6.318	176	16.58	6.657
Rudder Control	139	644	43.36	10.783	523	42.68	10.791	129	47.48	10.752	339	44.59	10.518	176	43.93	11.408
Personality and Leadership Measures																
Self-Description (103 items)	SDB	458	71.93	8.634	603	71.20	8.865	162	70.69	8.195	408	70.97	8.598	200	70.63	8.681
Qualification Report (OCE-2/OLR-1)	205a	758	113.66	22.060	603	111.78	22.914	155	121.52	18.366	401	114.91	20.540	123	111.55	23.778
Board Interview (OCI-4/OLB-1)	206a	758	27.65	6.590	603	28.10	6.638	155	25.49	6.399	401	26.92	6.233	123	28.75	6.942
Cognitive Tests																
Spatial Content Area																
Aircraft Orientation	150	765	7.73	5.656	603	7.18	5.575	162	9.79	5.947	408	8.13	5.741	123	7.69	5.347
Complex Movements	148	162	28.89	8.962												
Flight Visualization	151	765	6.39	7.524	603	5.58	7.485	162	9.41	7.668	408	6.74	7.705	123	6.17	7.769
Instrument Comprehension	152	763	16.53	6.547	602	16.22	6.659	162	17.69	6.113	407	16.62	6.514	123	16.72	6.672
Locations - Dark	121	162	14.69	4.033												
Locations - Total	122	162	28.98	7.178												
Spatial Orientation	154	765	16.83	10.993	603	17.43	11.005	162	14.56	10.948	408	15.46	11.394	123	17.95	10.959
Stick and Rudder Orientation	147	765	13.84	10.571	603	13.89	10.600	162	16.78	10.464	408	14.23	10.688	123	15.27	10.581
Mechanical Content Area																
Mechanical Ability - Form 2	157	765	36.32	8.035	603	35.85	8.297	162	38.05	6.973	408	35.91	8.022	123	36.71	8.200
Mechanical Functions	153	765	12.24	7.599	603	11.64	7.846	162	14.48	6.598	408	12.51	7.588	123	12.26	8.304
Mechanical Principles	159	366	12.13	5.754												
Aviation Information Content Area																
Flying Information	146	603	23.17	12.732												
Helicopter Information	149	764	37.02	14.816	603	36.55	14.837	162	41.65	14.741	408	38.14	15.131	123	37.35	13.759
Situational Reasoning Content Area																
Situational Reasoning	158	366	13.54	4.355												

Table B-3

FULL MATRIX OF INTERCORRELATION COEFFICIENTS AMONG PREDICTORS USED IN FINAL ROTARY-WING VALIDATION

		Psychomotor			Personality and Leadership			Cognitive: Spatial								Cognitive: Mechanical			Cognitive: Avn. Info.		Cognitive: Situational Reasoning
	Var. No.	144	136	139	SDB	205a	206a	150	148	151	152	121	122	154	147	157	153	159	146	149	158
Complex Coordination	144	—																			
Rotary Pursuit	136	366[a]	—																		
Rudder Control	139	341	285	—																	
Self-Description - 103 item	SDB	005	064	107	—																
Qualification Report (OCE-2/OLR-1)	205a	000	039	009	081	—															
Board Interview (OCI-4/OLB-1)	206a	072	008	004	-002	217	—														
Aircraft Orientation	150	336	157	197	006	-049	044	—													
Complex Movements	148	333	104	038	178	-132	096	406	—												
Flight Visualization	151	371	190	193	066	-099	078	551	390	—											
Instrument Comprehension	152	398	234	216	107	047	123	549	321	535	—										
Locations - Dark	121	151	058	-036	-035	-087	086	262	255	228	358	—									
Locations - Total	122	159	065	022	001	-069	089	360	313	310	438	929	—								
Spatial Orientation	154	387	217	224	042	-001	077	522	498	546	518	362	456	—							
Stick and Rudder Orientation	147	372	221	214	068	-087	125	552	393	529	560	453	506	545	—						
Mechanical Ability, Form 2	157	304	184	177	016	061	098	288	128	364	310	124	220	352	364	—					
Mechanical Functions	153	371	240	315	060	-030	040	480	196	520	477	135	225	487	505	514	—				
Mechanical Principles	159	274	026	162	119	-056	121	439	172	501	347	161	268	485	435	511	520	—			
Flying Information	146	273	138	180	-020	-047	107	408	200	458	400	240	330	388	500	456	460	491	—		
Helicopter Information	149	236	132	235	069	-023	121	380	202	425	404	244	343	357	426	487	455	386	686	—	
Situational Reasoning	158	080	-200	006	-001	027	069	152	113	218	184	157	194	271	239	232	223	453	374	166	—

[a]Decimal points omitted

Table B-4

REDUCED MATRICES OF INTERCORRELATION COEFFICIENTS AMONG ROTARY-WING PREDICTORS USED IN FIRST TRIAL OF FINAL VALIDATION[a]

	Var.	Psychomotor			Personality and Leadership			Spatial					Mechanical		Avn. Info
	No.	144	136	139	SDB	205a	206a	150	151	152	154	147	157	153	149
Complex Coordination	144	—	379[b]	368	095	015	072	354	380	413	392	398	325	393	265
Rotary Pursuit	136	319	—	275	160	037	008	130	179	212	228	216	186	227	139
Rudder Control	139	235	328	—	138	-015	001	199	183	200	220	221	188	319	215
Self-Description - 103 item	SDB	-084	-034	078	—	167	-002	-045	045	110	-025	038	014	100	110
Qualification Report (OCE-2/OLR-1)	205a	-076	048	135	-073	—	211	-035	-088	083	002	-074	086	-010	-018
Board Interview (OCI-4/OLB-1)	206a	068	008	019	-002	246	—	032	047	105	041	074	119	064	136
Aircraft Orientation	150	272	261	190	076	-113	091	—	551	532	520	555	295	494	366
Flight Visualization	151	337	234	232	095	-149	203	550	—	536	549	540	381	538	441
Instrument Comprehension	152	339	231	290	110	-138	205	618	534	—	511	544	326	503	381
Spatial Orientation	154	367	174	242	143	-012	224	530	534	549	—	552	381	513	336
Stick and Rudder Orientation	147	269	243	183	115	-152	329	545	490	627	519	—	386	534	427
Mechanical Ability, Form 2	157	210	174	119	021	-087	-001	266	296	234	229	269	—	524	498
Mechanical Functions	153	270	300	297	-002	-148	-077	434	446	353	375	380	462	—	471
Helicopter Information	149	124	102	315	011	-046	062	429	366	499	433	424	444	388	—

[a]Values above the diagonal represent intercorrelations for the validation sample (Samples IV' and IV'' combined).
Values below the diagonal represent intercorrelations for the cross-validation sample (Sample V).

[b]Decimal points omitted.

APPENDIX C

INTERCORRELATION MATRICES OF PREDICTOR AND CRITERION VARIABLES IN THE FLIGHT APTITUDE SELECTION TEST BATTERIES

Table C-1

INTERCORRELATION MATRIX FOR WARRANT OFFICER CANDIDATE FLIGHT APTITUDE BATTERY, ROTARY-WING[a]

Test	Mean	SD	Test 2	3	4	5	6	PFT Criterion
1. Aviation Information, R-W	8.70	4.34	.365	.341	.162	.342	.056	.243
2. Mechanical Functions	12.24	7.60		.520	.196	.505	.061	.299
3. Visualization of Maneuvers	15.13	7.16			.390	.529	.066	.277
4. Complex Movements	28.89	8.96				.393	.178	.342
5. Stick and Rudder Orientation	13.84	10.57					.068	.279
6. Self-Description Blank	71.93	8.63						.361
Composite	150.73	30.21						.478

[a]Intercorrelations are from USAPRO final validation study with appropriate adjustment for change in test length in the case of Aviation Information. Validity coefficients are taken from the same source.

Table C-2

INTERCORRELATION MATRIX FOR WARRANT OFFICER CANDIDATE FLIGHT APTITUDE BATTERY, FIXED-WING

Test	Mean	SD	Test 2	Test 3	Test 4	Test 5	PFT[a] Criterion
1. Aviation Information, F-W	10.15	7.56	.401[b]	.195[b]	.289[b]	-.018[c]	.270
2. Mechanical Information	15.95	6.95		.239[b]	.182[b]	.145[d]	.240
3. Visualization of Maneuvers	15.13	7.16			.468[b]	.066[d]	.285
4. Instrument Comprehension	15.62	8.42				.107[d]	.210
5. Self-Description Blank	71.93	8.63					.361
Composite	128.78	23.26					.457

[a]Validity coefficients are averages of those reported in USAPRO Technical Research Note 112 and Air Force report ASD-TN-61-52 (see page 42).

[b]From AFWAB-2.

[c]Based on correlation of Flying Information and final Self-Description Form.

[d]Based on rotary-wing data.

Table C-3

INTERCORRELATION MATRIX FOR OFFICER FLIGHT APTITUDE BATTERY, ROTARY-WING

Test	Mean	SD	Test 2	Test 3	Test 4	Test 5	Test 6	PFT Criterion
1. Biographical Information	23.70	6.36	.261[a]	.18[b]	.03[c]	.05[c]	.04[c]	.18[d]
2. Aviation Information, R-W	8.70	4.34		.365	.341	.162	.342	.243
3. Mechanical Functions	12.24	7.60			.520	.196	.505	.299
4. Visualization of Maneuvers	15.13	7.16				.390	.529	.277
5. Complex Movements	28.89	8.96					.393	.342
6. Stick and Rudder Orientation	13.84	10.57						.279
Composite	102.50	29.40						.424

[a] Based on correlation of Biographical Information with Aviation Information from AFWAB-2, adjusted for length.

[b] An average based on correlations of Background Inventory with Mechanical Principles, Aircraft Orientation, and Flight Visualization (Technical Research Note 112), also Biographical Information with Mechanical Principles, AFWAB-2.

[c] Estimated from available inter-r's on spatial tests and biographical or background information; differ only because of varying length.

[d] Validity coefficients are based on USAPRO validation data except for Biographical Information which is based on Air Force data (ASD-TN-61-52; see page 42).

Table C-4

INTERCORRELATION MATRIX FOR OFFICER FLIGHT APTITUDE BATTERY, FIXED-WING[a]

Test	Mean	SD	Test 2	3	4	5	6	7	PFT Criterion
1. Biographical Information	23.70	6.36	.366	.219	.286	.401	.186	.137	.18[b]
2. Mechanical Principles	15.03	6.61		.418	.304	.622	.396	.316	.24
3. Flight Orientation	30.50	17.52			.219	.201	.525	.498	.32
4. Aviation Information, F-W	10.15	7.56				.362	.195	.280	.27
5. Mechanical Information	15.95	6.95					.239	.182	.24
6. Visualization of Maneuvers	15.13	7.16						.468	.28
7. Instrument Comprehension	15.62	8.42							.21
Composite	125.97	40.54							.390

[a]Intercorrelations based on 404 cases administered the AFWAB-2.

[b]Validity coefficients are based on USAPRO validation data, except for Biographical Information which is based on Air Force data (ASD-TN-61-52; see page 42).

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13. ABSTRACT High attrition rates among post-World War II Army fixed-wing pilot trainees and helicopter (rotary-wing) pilot trainees became a serious problem in the Army's aviation program as the supply of experienced pilots who had been in the Army Air Corps was exhausted and it became necessary to train men who had had no previous flying experience. At the request of DCSPER, research was initiated in 1955 by the U. S. Army Personnel Research Office to develop instruments to select officers as fixed-wing pilot trainees and enlisted men as warrant officer candidate rotary-wing pilot trainees. Research programs were conducted involving the experimental testing of 2000 enlisted men, 1200 officers, and 1200 ROTC cadets. At the start of the program, major attention was given to development and evaluation of measures to select enlisted personnel for rotary-wing training, including preflight (OCS-type) training to prepare graduates for warrant officer commissioning. A number of interim test batteries, both fixed-wing and rotary-wing, were developed and operationally implemented. In 1963, reccommendation was made for the consolidation of the separate selection procedures into a comprehensive program. The present report summarizes the important stages in the separate fixed-wing and rotary-wing research and the more recent effort by which results were integrated in the development of a comprehensive selection program.

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Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
*Aviation Training Selection						
*Flight Aptitude Selection						
Attrition rates						
*Fixed-wing aviation						
*Rotary-wing aviation						
*Flight training program						
Psychological measurement						
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Cognitive tests						
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